MECHANICAL ENGINEERING

IN THE FIRST HUNDRED YEARS OF

THE OHIO STATE UNIVERSITY

1871-1971

by

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MECHANICAL ENGINEERING IN THE FIRST 100 YEARS OF THE OHIO STATE UNIVERSITY, 1871-1971

INTRODUCTION

The history of the Mechanical Engineering Department at The Ohio State University begins in Washington, D.C. on July 2, 1862, when the U.S. Congress passed an act donating land for schools of Agricultural and Mechanic Arts. On February 9, 1864, the General Assembly of the State of Ohio passed an act to accept the grant conveyed by the U.S. Congress. By January, 1865, things had progressed to the point that Governor John Brough in his annual message was able to announce that certificates of scrip for 630,000 acres of land had been received and placed in the treasury of the State of Ohio. To quote Governor Brough, "The entire object is to promote the liberal and practical education of the industrial classes." On April 13, 1865, the Ohio Legislature authorized sale of scrip at a minimum of 80¢ per acre with 6% interest going for the "endowment, support, and maintenance of at least one college where the leading object shall be - without excluding other scientific and classical studies - to teach branches of learning as are related to agriculture and the mechanic arts."

Things got off to a slow start selling scrip at the 80¢ per acre price. On December 20, 1865, the commissioners reported to the Governor that only 11,360 acres had been sold and that it would take ten years to sell the rest unless the price could be cut below 80¢ per acre. The Legislature was sympathetic with the problem and authorized a lower price. Most of the land sold at 53¢ per acre and total proceeds were $342,450.80. Through interest at the time of opening in 1873 the capital had grown to $500,000.

Between 1865 and 1873, there were considerable goings on related to the establishment "of at least one college." The net result was the establishment of only one college. The choice of city was another problem. It was resolved in effect by bids from interested cities. Five cities competed for the location of this Agricultural and Mechanic Arts College and Franklin County won by offering $300,000.00 in 7% bonds, $28,000 additional from citizens and two railroads, plus 317 acres of excellent land. (One can pause to give thought to how far we have come recalling a recent Columbus City Councilman stating in a council meeting of the City that the University was a "plague taking over the northern part of the City.")

Joseph Sullivant Esq. was certainly a guiding light on the local front with respect to establishing a college in Columbus. On January 6, 1871, ten departments were adopted for this college as were advocated by Mr. Sullivant.

1. Agriculture
2. Mechanic Arts
3. Mathematics and Physics
4. Chemistry
5. Geology, Mining and Metallurgy
6. Zoology and Veterinary Science
7. Botany and Horticulture

8. English Language and Literature
9. Modern and Ancient Languages
10. Political Economy and Civil Polity

Accepting a position with an unestablished college was as much a gamble a hundred years ago as it is today. By January 2, 1873, two people had refused the presidency and the faculty that had accepted were Thomas C. Mendenhall (Columbus) Professor of Physics and Mechanics. Professor Mendenhall enjoyed a reputation as a popularizer of science at that point. Sidney Norton (Cincinnati) accepted the position of Professor of General and Applied Chemistry.

Edward Orton (Yellow Springs) accepted the position of Professor of Geology, Mining and Metallurgy and did accept the Presidency of the University while retaining his faculty position. As for President Orton, history treats him kindly and he did much to establish the quality of the University which we enjoy today. His own life as he lived it must have been distressing at moments to him. As a geologist he was keenly aware of evolution in an age when evolution was not acceptable in our culture. Thus he found it necessary to leave the East where he was raised and educated . . . as well as branded an athiest . . . to seek the more open-minded midwest to pursue his works. He taught at Antioch College, rising to its Presidency before coming to Columbus to help this new college in its early struggles. Testimonies to Edward Orton abound, always eulogizing him as being loyal, fair, just, intelligent, highly moral in his teaching and dealings with faculty and students. One person did comment that he wore his hair slightly longer than fashionable in those days . . . Edward Orton would have loved Ohio's children today and, undoubtedly, they would have loved him in return.

Joseph Millikin (Hamilton) accepted the professorship in English and Modern Languages and W. G. Williams (Delaware) the Professorship of Latin and Greek.

To quote from E. A. Hitchock's volume of Early Days in Mechanical Engineering at The Ohio State University, "when September 17, 1873, rolled around, 17 students had applied for admission. It was strikingly evident that the location of the University and surrounding conditions provided at once a practical field for some lines of engineering training. Columbus at that time had a population of about 35,000. There was practically no town north of the Union Station. The University was located on the Worthington Pike, and there was a toll gate at what is now the intersection of High Street and Eleventh Avenue.

"On the college grounds there were no paved roads or sidewalks. The one and only, but uncompleted, building was University Hall. Its "doors" were opened on that September day, and no doors were in place. The building was surrounded by piles of lumber, iron and lead pipe, heaps of brick, sand, and miscellaneous building material. Here, upon the opening day, was an excellent illustration of architectural engineering, while the surrounding campus and neighboring territory offered splendid opportunities in the field of civil engineering.

"The seventeen students of opening day had grown to 90 students by the end of the first Year."

THE STILLMAN W. ROBINSON YEARS

From the circular and Catalogue of 1873 and 74, we find that the "subject of Practical Mechanics is at present connected with the professorship of Physics. Instruction will be furnished in the principle and uses of machinery, and also in its construction, and in mechanical drawing." We note that under Mechanical and Freehand Drawing, the study of Practical Lithography and Photography were taught. The Trustees indicate, in 1874, an awareness of a need to expand the laboratory for fundamental principles of machines.

In 1878, Stillman Williams Robinson was called to replace Thomas Mendenhall who requested a leave of absence to travel to Japan.

At this point, one would do well to consider the state of evolution of Mechanical Engineering, and to do so one must begin with Stillman Robinson who is a very key figure in the history of mechanical engineering as a discipline.

Stillman Williams Robinson was born on a farm near South Reading, Vermont, on March 6, 1838. His early life was that of a country boy, but he had such a love for mechanics that he served a four-year apprenticeship as a machinist. In this way he earned the money to defray the expenses of his early education and his preparation for college. From 1855 to 1859, Professor Robinson served as a machinist's apprentice in Vermont. We know that he entered the University of Michigan in January, 1861, having journeyed the minimum of 625 miles from Vermont on foot, working as a machinist enroute to meet expenses. We note from a subsequent volume of "Who's Who" that Professor Robinson at that time had an older brother who was also a student at the University of Michigan, and whose career at first overlapped that of S. W. Robinson. Their careers later diverged as the brother went on to make his mark in the Railroad industry, rising to the Vice Presidency and General Manager of the Atchison, Topeka and the Santa Fe R.R. Company and Presidency of the Mexican Central Railway Co. Ltd., while Professor Robinson turned inventor and educator.

At the University of Michigan Professor Robinson studied Civil Engineering, a course which was introduced there in 1860. This course gave the degree after three years of study with sophomore work in the Department of Literature, Science and Arts. For three years following graduation Professor Robinson worked with the United States Lake Survey. He then returned to the University of Michigan to serve as Instructor of Engineering in Civil Engineering and then as Assistant Professor of Mining Engineering and Geodesy until 1870.

It is known that Professor Robinson had definite opinions about how shop courses ought to be taught and what academic material was relevant to engineering - the question of relevancy has been with us for sometime - and that these were a factor in his accepting a position as Professor of Mechanical Engineering and Physics at the Illinois Industrial University subsequently renamed the University of Illinois. Illinois had a long standing battle over what the university should teach, what it was legal for it to teach, but suffice it to say that there are numerous reports indicating an "earnest desire to do everything in their power to promote instruction in the mechanic arts; but

Figure 1. The first home of the mechanical engineering program at The Ohio State University was located in the west basement of University Hall. This building was opened for classes with the Autumn of 1873, although the building was incomplete, even the doors were not in place. Mechanical Engineering, as a degree granting department, was established in 1882. Prior to this, the curriculum was taught under the Professorship of Physics and Mechanics. Professor Mendenhall was the first professor and he emphasized the physics of mechanics; however, the laboratories and many courses which were evolving between 1875 and 1882 are now known as Mechanical Engineering. The first Mechanical Engineering graduate (1880) entered the curriculum in 1876.

Figure 2. The Mechanical Engineering building which was first used in 1880. The contract for construction (1879) was $4, 550. The building consisted of two wings 32 x 77 feet and 32 x 61 feet connected by a two story wing which was 34 x 38 feet. The building contained 5 rooms. The one story wing on the right stands today and is named Alumni House.

Figure 3. The second Mechanical Engineering building. This building was finally contracted for in 1907; previously funds had been designated twice by the Legislature but both times the Chemistry Building burned and the funds were transferred to build a new Chemistry Building instead. This building, named after Professor Robinson, cost approximately $64, 000 and was occupied in 1908. The above photograph was made in 1918.

Figure 4. Looking east in 1969, on 18th Avenue, along the front of Robinson Laboratory. The west wing was completed in 1924. The increased enrollment due in part to the introduction of the automobile made it necessary to provide more classroom and laboratory space.

Figure 5. Stillman W. Robinson left the University of Illinois in 1878, while he was the Dean of Engineering, to accept the position as Professor of Physics and Mechanics at The Ohio State University. He developed the first mechanical engineering curriculum and was the first department chairman. In consideration of his distinguished services as a scientific inventor with well over 40 patents, an investigator and writer of many important technical articles and books, and for his services as an inspiring teacher, the university conferred upon him the degree Doctor of Science in 1896.

Figure 6. The senior laboratory class in Mechanical Engineering in 1897. Professor E. A. Hitchcock is the class instructor and on the left in the front row. C. H. Irvin, J. G. Bower, and Horace Judd are also in the front row. H. A. Rowlee, L. M. Hartwick, W. F. Gallen, J. H. Fox, C. W. Damron and R. M. Lee are in the back row, reading from left to right. Professor Hitchcock distinguished himself as a teacher and later as Dean of the College of Engineering.

there seems to have been no very definite conception of the object to be accomplished or of the methods and appliances to be used, until the advent of Professor Robinson," to quote Ira Osborn Baker, Professor of Civil Engineering at the University of Illinois as recorded in the 1912 Memorial Volume for S. W. Robinson. Professor Robinson obtained a $2000 appropriation from the Trustees and proceeded to set up the "first distinctly educational shop in American and seven years elapsed before another similar shop was opened in the United States (1878, OSU). In less than a year after the opening of this small shop in a former mule-stable, the Legislature appropriated $25,000 for a new mechanical and military building, which is the strongest evidence of the approval of the methods of instruction employed."

At this time in history there was a strong movement toward overlooking fundamentals in training engineers. Professor Robinson was opposed to this approach and emphasized a strong foundation in physics and mathematics as preparation for engineering.

To make matters more difficult at the time Robinson went to Illinois there was published a noted engineering handbook which boldly asserted that higher mathematics were useless to an engineer. "This statement greatly impressed the engineering students of that day" and it was left to Professor Robinson to demonstrate through his own understanding of the fundamental sciences the importance of the sciences to engineering practice.

During the 1860's, there was "much skepticism among practicing engineers as to the possibilities of giving by college instruction any conception of the principles and practice of engineering. In those days engineering students, . . . found it unwise to disclose the fact that they had taken collegiate training in engineering." Thus it fell to Professor Robinson to place his graduates with acquaintances of his where the graduates then aided in dispelling doubts as to the value of collegiate instruction in engineering.

This machine shop laboratory which Professor Robinson was operating at The University of Illinois is interesting to consider from the standpoint of the mission it was filling. The objective of The University of Illinois, like that of the other land grant schools, was to provide an education for the children of the industrial classes, those of modest incomes whose children might not otherwise be able to attend college. This machine shop was, in addition to being a learning laboratory, actually an industry staffed by students manufacturing goods for sale on the open market for the purpose of profit to be used to finance the education of the student-workers. Here we have in effect in the 1860's our Professor Robinson running a co-op education program 60 years ahead of its time.

This machine shop-laboratory reflects the sensibility and practicality inherent in the best engineers. Even then he bore the brunt of criticism from the classical academic areas. However, he had on his side the hard line of relevancy, just as much a factor then as today. There is little room for doubting the relevance of what one is doing if there is a line of buyers waiting outside the door.

In 1878 Professor Robinson left the University of Illinois where he was Dean of the Engineering College, because of "the condition of finances."

Two months after accepting the position at Ohio State, S. W. Robinson wrote his first report on the state of affairs. He records that there were in his charge a total of 69 students. Forty-six were studying elementary physics; 10 in the physical laboratory; 10 in the mechanical laboratory; and 3 studying mechanisms. He continues, "Instruction can now be given in most of the branches which qualify the student for the degree Mechanical Engineer. The only lack is in the Mechanical Laboratory facilities."

To remedy this lack of Mechanical Laboratory facilities, included in this early report was a shopping list of items needed immediately as installation would be time-consuming. "The things needed are a steam engine of eight-horse power, shafting, with its pulleys, belting, and hangers, two engine-lathes, two hand-lathes, one planer, one milling-machine, one drilling machine, one shaping-machine, one grindstone for power, and one blower for forges." Prices obtained for these items totaled $5,375.00. These items, with additions, were obtained and installed in the newly constructed mechanical laboratory. Part of this building still remains on the campus serving as the Alumni House. Prior to this time the mechanical laboratory had been located in the west basement of University Hall - where today one can view the brick floored cellar and, with sufficient quiet and imagination, almost hear the echos of the first laboratory classes.

As a matter of the philosophy of teaching engineering, Professor Robinson suggests that accomplished foremen and superintendents must be supplied by colleges. There was a segment of the population, presumably the trade unions, proposing four year apprenticeships plus four years of college to meet the requirements of "Mechanical Engineer." Professor Robinson had himself followed that course of education and was adamantly opposed to spending that number of years acquiring an education which he thought could be gained as well in less time with proper course presentation. His feelings were that engineering should have laboratory courses like other disciplines, and that "colleges of practical instruction must find an asylum where trade unions and mob rule cannot molest it".

In 1881, T. C. Mendenhall returned from Japan to resume his duties as Professor of Physics and S. W. Robinson continued on as Professor of Mechanics. There had always been two Professorships in these two areas, and at this point in time separate departments of physics and mechanical engineering were created facilitating area development with greater rapidity as the guiding faculty members were now free to concentrate on their own specialty areas.

While Physics and Mechanics were taught under one Professor, the course of study followed this plan presented in the 1873-74 Circular and Catalogue:

Everyone at the College takes a standard first two years.

Year 1 - term 1 - Physical Geography, English Language, Algebra
term 2 - Human Physiology, English Language, Geometry
term 3 - Physics, Botany, Algebra

Year 2 - term 1 - Physics, Chemistry, Zoology
term 2 - Physics, Chemistry, Geometry
term 3 - Botany, Chemistry, Plane Trigonometry, English Language
(History throughout the year)

The next two years are spent in 1 of 3 schools.

I. The School of Exact Science: embracing Mathematics, Civil Engineering, Physics and Mechanics and Chemistry

II. School of Natural History

III. School of Letters

For the student of Physics and Mechanics the subsequent two years follow this pattern:

Year 1 - term 1 - Mechanics
term 2 - Acoustics and Optics
term 3 - Optics

Year 2 - term 1 - Heat
term 2 - Heat and Electricity
term 3 - Electricity

There will be, in addition, an advanced course in Mechanics, comprising one year of laboratory work in the Mechanics of Solids, Liquids, and Gases, Strength of Materials, Elements of Machines, etc., combined with the study of Statics and Dynamics, and including the last year of the course in Physics. Throughout the whole course, the work will be very largely done in the laboratory and opportunity will be offered for special study in any direction coming within the range of the department.

Text Books in use then - some of which are still in the Main Library of the University -: Deschanel's PHYSICS; Todhunter's THEORY OF HEAT; Pickering's PHYSICAL MANIPULATIONS; Kilrausch's PHYSICAL MEASUREMENTS.

For the record, in 1873-74, tuition was \$5.00 per quarter, \$15.00 per year plus cost of laboratory materials consumed. Board and other expenses averaged \$70 per quarter. School ran from September 17 to June 22, with about a week free between quarters.

When Professor Robinson arrived in 1878, he outlined what his intentions were with regard to the training of Mechanical Engineers. From the annual Report of 1878, Professor Robinson states:

"The instruction in mechanic art which, it is believed, should be provided for at this University, by fitting up the Mechanical Laboratory, may be indicated thus: It should extend at least through four terms, or one and a third years, one exercise per day. Two years would be still better.

"The first term should consist of laboratory exercises in elementary practice four times a week with one lecture per week on tools and their use, and methods of practice. This practice would be elementary, confined to single pieces, and not including the fitting of parts together. Also, the practice should be guided by the eye and not by hand tools of precision, such as the square, rule, callipers, etc. The eye needs its training as well as the hand. This practice should be made up of lessons in woodwork preparatory to pattern making, in moulding and casting of brass, in the elementary operations of forging, such as lengthening, shortening, bending, welding, etc., in the elementary operations of the fitters bench, such as chipping, filing, finishing, etc.

"In the second term the above operations may be carried on to more complex pieces or forms, with the addition of machine tool work in elementary practice, such as preparatory turning, boring, planing, milling, drilling, etc., of iron. Hand turning should be included.

"In connection with this practice, one exercise per week should be devoted to the designing and drawing of machine elements, such as cranks, bearing-boxes, stuffing-boxes, stub-ends, pistons, etc.

"In the third term, the practice should be extended to the fitting of parts together in pairs, such as chipping grooves and filing pieces to fit, planing grooves, and pieces to fit, boring holes, and turning pieces to fit, fitting wood and wood, wood and iron, etc.; also, the surfaces of pieces should be finished or polished by use of emery, burnishers, etc. The student should also be familiarized with the use of the scraper in making perfect joints.

"In connection with this third term's work, there should be one exercise per week at inventing and drawing of simple machines, for doing such acts as bending wire into staples, cutting out wooden combs, turning handles, etc.

"The fourth term should either follow or be in connection with the study of mechanism, so that problems in mechanism can be worked out, and the parts constituting the movement, and its frame-work or supports, made in the laboratory. This would be construction, the results being models of mechanical movements suitable for the cabinet of models. In this way the cabinet may be constantly increased. In the terms preceding this we have instructive practice, while in this, constructive practice, in which we have application of the skill acquired in the earlier practice.

"The remaining technical studies are such as the strength of materials, thermodynamics, machinery and mill-work, prime movers, machine designing and drawing, etc., which will be provided for by lectures, for the most part, as classes mature for them."

From the 1879 Annual Report the program for the degree of Mechanical Engineer is outlined as follows:

SOPHOMORE YEAR			
First Term	Projection Drawing	French*	Mechanical Lab.
Second Term	Descriptive Geometry	French	Mechanical Lab.
Third Term	Calculus	French	Mechanical Lab.

JUNIOR YEAR			
First Term	Geology	Physics	Analytical Mechanics
Second Term	Geology	Metallurgy	Mechanism
Third Term	Astronomy	Metallurgy	Mechanism

SENIOR YEAR			
First Term	Thermo-Dynamics	Physics	Strength of Materials
Second Term	Prime-Movers	Physics	Technical Drawing
Third Term	Mill-Work	Physics	Technical Drawing

EXPLANATION OF THE COURSE

"In the Principles of Mechanism are studied the parts of machinery by pairs; or elementary combinations of mechanism. In this the form and arrangement of the parts necessary for securing the desired modification of motion is sought.

"In the Machine Designing the student takes up some problem in the shape of a particular machine for a special purpose. The forms, dimensions, and arrangements of the parts are decided upon, and then a drawing is carefully made of the whole. Detail drawings to regulation size are then made, and finished in shade lines, as done in the best shops. The quality of these drawings is sufficient for the requirements of photo-engraving for illustrations upon circulars.

"In Thermodynamics are studied the principles which form the groundwork of all heat engines.

"In Prime Movers are studied all kinds of heat engines, such as steam, hot-air, etc., and also wind and water-wheels.

"Mill-work and machinery takes up valve-gears, fly-wheels, governors, efficiency of parts of machines, strength of parts, etc.

"The Mechanical Laboratory is intended for acquainting the student with the materials used in machine construction; with the forms customary in machinery; to impart a degree of skill in the use of tools, and a knowledge of the operations and practice of shops.

*The inclusion of a modern language as a part of the requirement for a degree in engineering seems to have been a compromise as Robinson often privately and sometimes publicly expressed the opinion that the young man who came to this University for an engineering training should be as well prepared as possible and should not be compelled to devote a considerable portion of his time to the study of a modern foreign language. Nearly ninety years later the requirement has been dropped from all degree requirements including the Doctor of Philosophy Degree.

"The first term consists of the actual use of tools in executing a set of forms chosen, with a view to supplying the greatest possible amount of practical instruction for the time. This is combined with weekly lectures on tools and their use.

"The second term carries the above practice to the fitting together of parts and to the use of machine tools, such as the lathe, planer, etc. This is combined with weekly exercises in designing and drawing of machine elements, such as cranks, bearing-boxes, stub-ends, etc.

"The third term is fully occupied in fitting parts carefully together, as in the joining machinery, and in finishing the surfaces by scraping, polishing, burnishing, etc. This is in combination with a weekly exercise in the invention of simple machines for specific operations, such as bending wire staples, cutting wooden combs, etc." (This course in invention is referred to in October, 1888, by one Ralph Davenport Mershon who was at that point in Professor Robinson's class in inventions. "We have a class in Invention," writes young Mershon in a letter to his mother, "Professor Robinson gives us some simple machine to invent and then when we hand in our sketches he points out the weak points in the machine, tears up the sketch and tells us to try again." That the class was well taught is verified by the subsequent inventions of this particular mechanical engineering graduate which have endowed both the Mershon Auditorium as well as the Mershon Center for Education in National Security.)

"The fourth term of Mechanical Laboratory practice is constructive. It is taken in connection with the principles of mechanism. In the latter, problems in mechanism are worked out, forms and dimensions assigned to the parts, and then these are executed in the Laboratory, resulting in models of mechanical movements for the cabinet.

"Projects will be assigned to the student, from time to time, on topics connected with his studies, requiring him to take indicator cards, test the efficiency of boilers, visiting manufacturing establishments, etc., and report. Such reports should be neatly made out on the regulation papers of the Department. These will be taken in part, for the examinations, and retained for the cabinet."

The formation of separate departments for physics and mechanical engineering, beginning with the academic year 1881-1882, provided Professor Robinson with the opportunity to make curriculum changes which would more reflect his progressive and evolving views for mechanical engineering education. Particular changes made were as follows: (1) the freshman year included spherical and analytical trigonometry, higher algebra and land surveying; (2) the sophomore year analytic geometry, differential and integral calculus, physics and projection drawing. (3) the junior year was for mechanical laboratories and design and (4) the senior year included pneumatics and hydraulics. The curriculum was essentially fixed with little selection or course work allowed outside of the technical mechanical area. The education philosophy was to develop a graduate who was sufficently schooled in engineering practice so that he could begin work as a practicing engineering professional.

1881 saw the completion of a building to house mechanical engineering. Part of this 1881 building still stands and is currently known as the Alumni House located at the northwest corner of 17th Avenue and Bohannan Street. Around 1884, people were beginning to think about electricity and its potential. Some equipment (a 7 hp engine and Edison dynamo) was added to physics.

In April, 1884, Professor Robinson was instructed to have the water and gas pipes and fixtures in the chemical laboratory properly repaired. Professor Robinson was appointed to a committee to investigate dormitory water supply and to report changes necessary to secure pure water supply in dorms.

In 1886, Professor Robinson saved the day by observing that the tower of the main building had sustained widening base cracks and crushed bricks toward the top. The tower was in grave danger of falling by some disturbance as frost or cannon firing (that's no joke as the military science people fired cannons in front of the building regularly). The tower was repaired at the expense of $2,735 - the equivalent of the president's salary. We note that in 1969-1970 the main building is again in grave danger, having been scheduled to be destroyed.

In 1887, after several years of public clamoring about the uselessness of college educated people, the President's Report to the Trustees reports (an echo of a previous report on Professor Robinson's activities at the University of Illinois), "No part of the university calls forth more favorable comment than the mechanical laboratory. Its interests impress the visitor by its obvious usefulness and its adaptation to its purpose. It furnishes the kind of industrial education to which the public mind has of late been specially directed."

During this same year, a student in the department wrote to his father, "I thouroughly enjoy my work . . . I can only console myself with the thought that those who are most brilliant and learn quickly are not always the ones who succeed best in life." This observation was made by Ralph Mershon who later became one of the great benefactors of his fellow man. A further discussion shall be presented on Ralph Mershon.

In 1888, Professor Robinson prepared a display for Mechanical Engineering to be shown at the Ohio and Cincinnati Centernial Exposition. Included were: (1) 30 models of mechanical movements, (2) a case of standards and a Pratt and Whitney measuring machine, (3) a set of practice pieces of the laboratory work, (4) framed plates showing an illustrated program of the laboratory work, and (5) a set of babbitted boxes used in lubricant testing.

Along about 1890, Professor Robinson and the Mechanical Engineering Department found themselves cooperating with former President Rutherford B. Hayes in establishing manual training at OSU. In fact, much of the equipment from the manual training laboratories and the forge room were transplanted to Hayes Hall for use in the manual training program. Subsequently, by prior conditions referred to on page 81 of the 1891 Annual Report, the mechanical engineering students received their manual training under the Industrial Arts Department, and the now freed space was rapidly utilized as a testing laboratory for mechanical engineering

The mechanical building now had four rooms available with a total of approximately six thousand square feet of laboratory space. An instrument and model room were located on the first floor and a classroom for recitation was located on the second floor.

Professor Hitchcock pointed out that some of the necessary faculty activities, if Mechanical Engineering was indeed to continue its' growth in size and stature, were precipitated by the reluctance of the legislature to appropriate adequate funds to equip the laboratory. For example, Professor Robinson determined the needs for the laboratory and submitted a request for $10,000 in 1891. The appropriation was for $3,000 in 1893-1894. Consequently Professor Hitchock noted that he and Professor Robinson, the total faculty at that time, "adopted a policy of beg, borrow, and search old scrap piles for any mechanical device which possessed experimental possibilities."

It is interesting to observe that throughout the first 90 years of Mechanical Engineering at The Ohio State University, the faculty has continued this policy, by reason of necessity, since a position of mediocrity was never accepted as an allowable role for the department. The success in obtaining modern laboratory equipment is not due however to the faculty alone. Our alumni must be acknowledged since our graduates have generously given their support, and with this support the great educational heritage given to us by Professor Robinson has continued.

During the several years which were required to equip the Mechanical Laboratory Professor Hitchcock notes that "William C. McCracken, chief engineer, cooperated in every way, rendering valuable assistance with excellent suggestions and often times donating equipment which, though in satisfactory operating condition, had reached its capacity for meeting the service demands of the University." While this laboratory was being equiped the decision was in progress to demonstrate that a new power plant should be provided. An insight into the discussions which lead to this decision can be gained from Secretary Cope's report to Governor McKinley:

> The specification for Orton Hall provided for its ventilation by means of a fan impelled by an electric motor, and the plans for equipping Hayes Hall contemplated the purchase of a steam engine to furnish the power for driving the machinery. Consideration of the best means of supplying the power needed in these buildings led to the investigation of the subject of electric power for both these buildings and of its application to the various general requirements of the University.
>
> In this connection were considered also, the equipment of a testing laboratory for the department of mechanical engineering and the furnishing of electric light for the various buildings.
>
> Plans and estimates were submitted by Professors Robinson and Thomas, which contemplated the institution of a central power plant, to be located in the machine room of the Mechanical Laboratory, with circuits to the various buildings through the tunnel of the steam heating plant.
>
> This plan was finally adopted. A 100-horse-power engine and large dynamo were purchased and located as above recommended. Circuits were laid to Orton and Hayes Halls, to chemical laboratory and to farms. Motors were also purchased for the machine and forge rooms at Hayes Hall, for the mechanical laboratory, for the

> fan in Orton Hall, and for driving the machinery at the farm barn. The ventilating fans at Hayes Hall and the chemical laboratory had before this been run by small steam engines. These were replaced by street-railway motors secured by Professor Thomas as a loan from the General Electric Company, and the engines were transferred to the testing laboratory. (This transfer was carried on under the direction of E A. Hitchcock.)

President Scott added these comments to Secretary Cope's report

> An important step was taken when the Mechanical Laboratory was converted from a laboratory for elementary work into one for testing and experimentation. The elementary work is now done with greatly improved and extended facilities, and at the same time its removal to Hayes Hall has opened the opportunity to introduce in its former place the machinery and apparatus necessary for advanced work. The location of the new engine and dynamo in this building has made them available to the department for instruction. . .
>
> The need of more rooms is becoming evident. It will be impossible to enlarge the means of illustration and experiment to what they should be and provide for all the lines of work that such a department should carry on, until a new and large building has been erected or a commodious addition has been made to the present one.

Professor Hitchcock writes that the "Installation of new equipment in the mechanical building went forward quite rapidly and as fast as could be expected, coupled with laboratory classes in session at the same time. The two faculty members, Professor Robinson and Mr. Hitchcock, were rather proud of what was accomplished during the year. It was a case of planning and superintending at odd times, with one helper and student labor, while Mr. Hitchcock had 16 hours of instructional work and Professor Robinson 49 hours.

"The close of the college year 1893-94 witnessed the mechanical building not only well on the road to being an exceptionally well equipped experimental laboratory, but also with the beginning of a University power station. The power plant consisted of a Buckeye simple engine belted to a 100-k.w. 500-volt D.C. generator, a 30-k.w. 1000-volt A.C. generator also belt driven, and a switch board--all located in the north half of the former machine room. This plant was put into operation in September, 1893, under the supervision of Mr. W. C. McCracken.

"The south half of the machine room provided space for the Riehle 42,000-lb. testing machine, the Thurston lubricant tester, and the 48-in. disc ventilating fan with its "home-made" power transmission dynamometer.

"To the north, the first room was the steam engine laboratory where the two steam engines removed from the basements of the Chemistry Building and Hayes Hall were installed. These steam units were 8-in. x 12-in. and 12-in. x 12-in., sizes suitable for compounding; therefore, they were so set and connected up with receiver, surface condenser, and air pump that they could be run compound condensing or non-condensing, or as simple engines. A load was applied by means of a pony brake on the jack shaft to which the two engine units were belted.

"In this steam room also was the small compound engine designed and built by Professor Robinson which for several years ran the machine tools in the south room. With this unit's removal to make room for the Buckeye power plant engine, power for the south room main line shaft was obtained from the jack shaft of the steam engine room by means of a single strand double rope drive with a traveling take up. Other steam laboratory equipment consisted of several types of steam injectors equipped for testing, and also throttling and separating calorimeters.

"Professor Robinson had been teaching theoretical hydraulics combined with the subject of mechanics. With the re-equipping of the mechanical building for experimental purposes came an opportunity to set up a hydraulic laboratory in line with the principles taught in the classroom. The room which had been the foundry was used for that purpose. By the close of the college year 1893-94 the laboratory--exceptional for its time--was ready, with a stand pipe and connections for orifice testing, two large cisterns with connecting weirs, turbine and impulse water wheels, centrifugal pump, three steam pumps, hydraulic ram, pulsometer, independent triangular weir, and Ericsson and Rider hot-air pumping engines.

"In the extreme north room of the mechanical building was placed the Westinghouse air brake equipment with which Professor Robinson made some interesting and valuable studies in air flow.

"A 48-inch disc ventilating fan played an important part in the laboratory experimental work of those early years. This fan was used extensively in studying the flow of air through large orifices, and for this purpose a transmission dynamometer was devised and constructed in the laboratory. This was before the day of the electric motor became universally used for measuring power.

"The difficulty Professor Robinson and his students experienced with this home made power measuring device prompted him to bring into play his wonderful inventive ability in developing a transmission dynamometer which was simple, adaptable, and accurate. The first one was made here in Columbus in 1894-95 at a cost of $304. Later the Riehle Testing Machine Co. of Philadelphia made the Robinson dynamometer commercially. This dynamometer was located in the north end of the north wing of the laboratory in position for belt testing with an absorption dynamometer or for driving the 48-inch disc ventilating fan at the right. . . Also in this north room, just to the right of the dynamometer, was an apparatus for studying moment of inertia.

"About this time greater attention was being paid to the value of pipe covering in reducing heat losses. Therefore, a pipe covering test apparatus was installed, upon which four different types of three-inch covering could be compared with an uncovered section of three-inch pipe.

"Professor Robinson continued to use the second floor room as his principal recitation room until 1894-95 when the classes in mechanism and mechanics became so large that a second floor room in University Hall was required. The first floor corner room was now devoted exclusively to the instrument and mechanism model cases and tables for calculation and writing.

"In the fall of 1894 a very valuable addition was made to the new University power plant located in the Mechanical Building machine room. It was a McEwen compound engine, placed in proximity to and parallel with the Buckeye simple engine which had gone into operation in September, 1893.

"Several years earlier, Professor Robinson enrolled a special student in his classes named J. H. McEwen from Wellsville, New York. Mr. McEwen* became especially interested in the principles of an inertia steam engine governor whichProfessor Robinson was demonstrating to his classes and in addition, had designed and was building for application to the little compound engine running the machine room. The usual types of governors on most high speed engines at that time were of the centrifugal principle only. The inertia type was a new departure and capable of much closer regulation.

"Mr. McEwen's interest as a student not only prompted him to go into high speed engine manufacture, but also to promise to donate a simple unit to the University when it had a power plant in which to install it.

"Professor Robinson did not forget that promise, and, accordingly, Mr. Hitchcock visited the J. H. McEwen Manufacturing Co., at Ridgeway, Pa., in June 1894. Hitchcock suggested to Mr. McEwen that a compound engine would be more in keeping with what was then planned for the power plant. Although a compound unit was of considerably greater cost, Mr. McEwen generously agreed to furnish it for the small sum of $150. It was put into operation that fall, belt driving a 30-kilowatt single phase alternating current generator.

"Thus the Mechanical Building was serving a double purpose, housing both the new experimental laboratory and the University's first power plant. It was a very busy place and also well equipped compared with similar laboratories in mechanical engineering at other universities.

"It was most gratifying, during the installation period of a year or more, to witness the generous response of many manufacturers to the suggestion of donating an example of their products. Many donated outright, others made generous reductions in prices. . .

"It undoubtedly was apparent to President Scott and the Board of Trustees that the Mechanical Engineering staff showed a satisfied attitude over what had been accomplished during 1893-94 because the small sum of only one hundred dollars was allowed for apparatus and supplies for the year 1894-95. However, this rather limited allowance did not interfere with the begging or borrowing attitude of the staff toward industry; Robinson and Hitchcock showed no hesitation in that direction.

"During the fall of 1894 there was considerable interest in the department aroused by the arrival and installation of the McEwen compound engine and also by the moving of the Otto gas engine from the Department of Physics. The Otto engine had been installed in 1876 in the west basement of University Hall, primarily to supply the Department of Physics with small amounts of power during

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*J. H. McEwen entered the University in September 1879 under the unclassified group, continued for four years, but lacked one term of graduating. He later became the manufacturer of one of the most successful high-speed steam engines in the United States.

the non-heating season when no steam was available for that purpose. This gas engine was one of the very earliest developments in the field of internal combustion engines, and the only one on the campus. It was available for indicator practice, and since its use for power purposes had been discontinued it could be used entirely for experimental work. But it was located in a most uninviting dark room and very close to a foundation wall of the building. Upon the recommendation of Professor Robinson to President Scott, the Board of Trustees authorized its transfer to the Department of Mechanical Engineering. Its original cost was two hundred dollars."

During 1892, Professor Robinson and the college engineer, McCracken conducted tests on the "Murphy smoke consuming" furnace and the regular furnaces in common use. A 28.7% savings using the Murphy furnace resulted with the Murphy furnace giving out 1/3 the smoke (economy and air pollution were of concern even then) of ordinary furnaces and the added report that with careful firing it can be made to consume "nearly all the smoke."

From the Memorial Volume we learn that in 1890, Professor Robinson organized an association composed of mechanical engineering teachers which in 1893, developed into the present American Society for Engineering Education. This transpired at the World Columbian Exposition at Chicago which was the spot George Westinghouse had chosen to demonstrate the application of alternating current by lighting the exposition. Professor Robinson was there and came home with George Westinghouse's experiment for in the Trustees Report to Governor William McKinley dated June 30, 1894, we see that "Professor Robinson and Professor Thomas submitted plans for a 100 hp engine and a large dynamo to be installed in the mechanical laboratory machine room to supply electricity to Orton and Hayes Hall, to the chemical laboratory, and to the farm. General Electric loaned street railway motors to drive ventilating fans. Westinghouse loaned a 600 light alternating current machine which made incandescent lights possible for Orton and Hayes Hall and temporarily in the Main and some of the other buildings." This was eight years after Westinghouse had perfected and demonstrated the first ac transformer.

On the topic of equipment given or loaned by industry, it would do well to elaborate. Presumably a field such as mechanical engineering would relate to the industrial world and obtain industrial support in return for students trained to fit the needs of industry. This was indeed the case as page after page of equipment donated to the Mechanical Engineering Department by industry are cited in the Proceedings and Annual Reports. To choose 1883 as a randon example, Professor Robinson says, "It is hoped that the department may be as well sustained by material aid from home as from abroad. With respect to the latter, I take great pleasure in stating that the department during the year has received valuable presents amounting to something like $800.

"One of these donations is from James Leffel and Co., of Springield, Ohio, consisting of a complete turbine water-wheel, such as is supplied by that company to its purchasers. It is a 15-inch iron wheel, regularly fitted up in an iron case, with proper mountings, water-gate, etc. This serves a very useful purpose as a model of a turbine wheel, for illustrating the lectures on turbines, and to form a permanent exhibit of one of our most important prime movers.

"Another liberal donation is from the Westinghouse-Air-Brake Co., of Pittsburgh, Pa., consisting of air-pipe, main reservoir, auxiliary reservoir, brake-cylinder, pressure gauges, cocks, couplings and connecting hose, brake-lever and valve, and excepting the driver-brakes, all needed equipment for an engine and tender as fitted up in actual railroad practice for passenger train service. These will serve the purpose of illustrating one of the most important and useful inventions of the country, so important as to have contributed greatly to the saving of human life. The apparatus will also provide a most valuable means for experimenting in the flow of air through tubes and orifices. It is hoped that new light may be added by these experiments to our present knowledge of this subject.

"Another donation is from the Crosby Steam Gauge and Valve Company of Boston, consisting of an elegant nickel-plated standard pressure gauge, indicating pressure, lb. by lb., from 0 to 160 lbs. This is in skeleton form, and is thus all the more useful for illustrative purposes.

"An elaborate lot of specimens of <u>Spiegel</u> ores have been received from the Fort Pitt Foundry and Steel-Works of Pittsburg.

"The department has also been presented with a set of the Grinnell Sensitive Automatic Sprinkler and Fire Alarm, by the Providence Steam and Gas Pipe Company of Prividence, Rhode Island. This sprinkler is a recently invented device for automatically extinguishing fires in compartments. . .

"Three models of mechanical movements have been added to the department cabinet by students of the Mechanism class."

University Engineer McCracken was very cooperative with Professor Robinson and often they worked together for the betterment of the University. The campus power plant was in itself an extension of the facilities available to the mechanical engineering students - the 1893 catalogue, after describing the facilities and buildings, adds that much more is included as a number of boilers, engines, blowers, steam and gas transmission pipes in tunnels for service with the various buildings of the institution are fitted with attachments for conducting experimental tests.

This was indeed a two-way cooperation and many of the gifts given to Professor Robinson were utilized across the campus, with the reservation that the mechanical engineering students should have access to them for learning purposes . .viz., the first electric lights, etc.

Professor Robinson was very astute in placing such high value on the availability of current mechanical innovations for his students. This array of apparatus at the University is reflected in the choice of employer made by the students when they left and went to industry - as well as by the inventions of the students following graduation. Frequently students would subsequently design an improved device with which they had come in contact in the department and their entire careers would evolve from that focus.

This insight into the nature of young people is still valid today and we should find operating on our campus models of rapid transit systems for future cities, electrically powered automobiles, robot lawnmowers, nuclear power stations, miniature agro-economic complexes, etc., if we are to continue to stimulate ideas and interest in the area of mechanical engineering among the youthful visitors of the campus and if we are to send to industry graduates with forward vision of the degree shown by the graduates of Professors Robinson and Hitchcock.

To further contrast the past with the campus problems of the centennial year it should be noted that at about this time in history President Scott reported to the trustees that "Students worry over examinations, they tend to procrastinate and then cram. This is injurious to themselves via physical prostration and derangement. No solution is proposed, it is only admitted that this is a problem." He also commented that the "history of athletics indicates that some limits should be prescribed. The evil that attends the present system of athletics is its interference with university work." Students and faculty alike presently find it difficult to approach the campus for research or work on a football Saturday as is their practice during the non-football Saturdays during the remainder of the year.

During the period of time in question, 1878 to 1894, Professor Robinson's incomplete list of patents and publications (apparently he listed 1/2 to 2/3 his actual output) indicates he was issued 25 patents at a minimum and published 7 books and treatises of major magnitude as well as 42 publications in journals. On the average then, over a twenty year period he published two times each year, he received between one and two patents each year, published a text every third year, and carried as high as 49 student contact hours. Aside from this, his first wife died and he remarried during this period.

PROFESSOR HITCHCOCK JOINS THE FACULTY - (1892-1893)

The rapid growth of the department made it necessary to add additional faculty. Professor Hitchcock joined the university community in January of 1892. Mr. Hitchcock's background included a degree in Mechanical Engineering from Silbey College, Cornell University in 1890. He was recommended to Professor Robinson by Mr. R. H. Thurston, the director of Silbey College. He had about three years of industrial experience prior to joining the Ohio State faculty.

Negotiations leading to the appointment of Professor Hitchcock promote some insight into the enthusiasm of this young man as well as into the character of Professor Robinson. A few excerpts from this correspondence follows:

Hitchcock to Robinson, November 29, 1892:

> Everything set forth by you is quite clear and I like the outlook, but what I want to know is whether or not my work would be eventually in connection with and relating to the Mechanical Lab. exclusively. If so that would suit me so much the better.
>
> You speak of $1200 salary. Do I understand that that amount is for the college year or calendar year?

Robinson to Hitchcock, December 1, 1892:

Yours of November 29th received. I am very glad to note you do not at once decline, and that you will consider, and I hope you will accept.

Answering points raised, 1st as to kind of work. . .Junior year, Mechanical Lab., 3 hours through the year, and explained as Mechanical Engineering, 2 and 3. . .To explain this further, there might be some explanation of use of a particular dynamomenter, or how to go systematically at a course of testing of a motor, lubricant, material, etc., where student should take notes and make final transcript for preservation. . . .

In spring term, Mechanical Engineering 3, is to lay out a mechanical movement accurately and then make it. This would be the only tool work. (Unless for this year only you help in wood work.)

Then for senior year,. . . Mechanical Lab. 5 hrs., Mechanical Lab. 3 hrs., Mechanical Lab. 5 hrs. for the 3 terms respectively. This is testing, explanations, etc., more advanced than in Junior, embracing hydraulic experiments, flow of fluids, steam quality, engine tests, using dynamometers, thermometers, gauges, calorimeters, anemometers, etc.

Now besides this, in dividing work of department between you and me, I think it might be necessary for you to take class in Invention Drawings 5 (Junior 1st term) and Technical Drawing 6 (Junior 3rd term and Senior 3rd Term).

As to Testing Laboratory, the present Mechanical Building, embracing 1 room 30 x 60 ft. and 3 rooms 25 x 30 ft. each (4 rooms all), will be given to this exclusively for inst., appliances, etc., partly on hand and partly to be gotten at as early date as possible. Besides this we are about to erect a Power House and Testing Laboratory to be 40' x 80' according to present instructions to architect. With 1 ground floor space. In this we will put from 4 to 7 engines and 3 dynamos or more. Have 5 engines now and expect 1 new one soon as can be gotten from factory. It is promised now. And another which I hope to be compound condensing Corliss and may have to wait for this last a year or two. Electric power will be transmitted to other buildings to run ventilators, machinery, etc., including our Manual Training Building machinery. Have some 50 H.P. of blowers to run. This power house machinery will be at our disposal for testing purposes. Will have an excess we can go on; 1st must run the blowers and machinery, and 2nd do our testing. I believe no trouble to have the needed service for testing purposes. With all these going I think will be in good shape. Besides this we have about 500 H.P. Babcock & Wilcox boilers in 4 sets in our building with 50% excess we can go on for testing purposes. Have some 800 ft. 8" x 6" steam pipe in a 5' tunnel we can use for steam pipe testing. Now this will be about enough for one to do and be very interesting work and I think exactly such as you mention as preferable.

2nd, as to salary. The salaries here are paid in 10 months, 1/10 each month and as a rule we are expected on duty only the school year, Sept. about 15 to June about 20. But sometimes we do some extra, in getting Departments in running order, etc.; although we do not expect vacation work we sometimes do it to extent we may volunteer.

I would like the assistant to be willing to serve according to need instead of minutia of bonus. For instance, if I needed to be away 2 or 3 days at a time, and could have my class work go on by written questions on board, and written answers by students would like assistant to take classes for that and also help in going over written answers, etc. In short, I would hope to have the assistant in heart with me for the Department of Mechanical Engineering.

Can you come here and look over the ground? Hoping you will accept, be assured of my best efforts to make it pleasant for you, I remain,

Yours faithfully,

(Signed) S. W. Robinson

Robinson to Hitchcock, December 12th, 1892:

Yours of December 6 duly received and I am much gratified to learn that you can accept the position.

I should have said in my letter that I am on a committee with our President, Dr. W. H. Scott; to select a man; and that I have not authority myself to close up the engagement.

On receiving your last, however, I had a conference with Dr. Scott and I will say that he is very favorably impressed with the showing I made to him; and I believe the matter is practically settled. He suggest that, if possible, you visit us before requiring him to give his decision in the matter, and as you speak of being in western N.Y. holidays, cannot you come over at some time convenient to yourself, and meet our president; as well as assuring yourself in the matter of position.

I now agree to refund to you the expenses of the trip from western N.Y. and return in case you do not undertake the position.

Our next term opens January 4th and that will be soon enough for you to commence duties. On the Monday following if you require the time. If you prefer to make visit late as January 2nd so as not return from here, that will answer. But we would be glad of notice of time of visit.

In meantime I would be glad to learn your age; nativity; whether married and whether ever apprenticed at machine trade. Perhaps I ought to mention that I would regret use of tobacco about the laboratories.

I am particularly gratified to note in your letter your frank determination to do your part to make the Mechanical Department here a success and a credit to us all. . . .

Mr. Hitchcock writes that "As a result of this correspondence with Professor Robinson, Mr. Hitchcock landed in Columbus the Friday morning of December 30, 1892. He reported to the professor at his residence at 1353 Highland Street, and they at once adjourned to the Mechanical Building. Their means of conveyance was by horse and carriage, the type of transportation used by the professor during all the years of his active connection with the University.

"Although Mr. Hitchcock had heard of Professor Robinson some four years before in his machine design class through the use of the Robinson odontograph, he had never heard of The Ohio State University, and was quite surprised at the small amount of experimental equipment in the Mechanical Building. He realized that there was every justification for the positions taken by President Scott and the department head that expansion should be in the direction of experimental engineering.

"The machine tools of the laboratory were driven by a 10-horse-power compound engine which could be used for indicator practice but was limited to almost a constant load in the driving of the laboratory tools.

"This engine, which had been designed by Professor Robinson, with the smaller parts built in the laboratory, was of the cross compound type but with cranks at 180 degrees. Joseph N. Bradford, M.E. class of 1883, who was assistant in the department when the engine was installed and put into operation, told Professor Hitchcock that it seemed to use an excessive amount of steam. With the professor's consent, Bradford spent a Sunday at the laboratory investigating the engine and found that one cylinder was working against the other because of an error in setting one eccentric. As was characteristic of the professor, he expressed considerable delight when he was informed of the trouble and his attention was called to the small amount of steam the engine used after the defect was corrected.

"This little unit was important in the early development of mechanical and electrical engineering at Ohio State University. In 1886-87, Professor B. F. Thomas of the Department of Physics, successor to T. C. Mendenhall, installed two direct current arc lamps in the University Chapel. The electric current for these lamps was generated by a small dynamo located in the mechanical building and driven by a special iron pulley on the west end of the laboratory line shaft, which, in turn, was driven by the little engine. This combination, therefore, constituted the first electric lighting service on the campus.

"In 1893 Professor Robinson designed and had made a governor for this unit based upon the inertia principle. This installation some years later assisted in settling a dispute as to priority between two engine manufacturers who were introducing the inertia factor in their governors.

"After inspecting the Mechanical Department, Messrs. Robinson and Hitchcock called upon President Scott at his residence at the corner of High Street and the campus entrance. Dr. Scott approved Professor Robinson's favorable attidude. Consequently, Mr. Hitchcock took on his new duties at once and was duly elected several days later by the Board of Trustees as assistant at a salary of $1,200.

"The following five months were rather discouraging for one who, for the previous four years had been in an atmosphere of considerable experimental equipment and exceptionally high class steam machinery. The problem of guiding fifteen advanced laboratory students in the 1893 winter term and twelve in the spring term, plus fifteen students in a class of technical drawing, was far from easy, particularly with the complication of very limited equipment. Nevertheless, it was a great delight to Mr. Hitchcock to know that he was materially lightening the load upon Professor Robinson, even though very little laboratory experimentation of an advanced character could be carried on.

"However, an excellent opportunity did arise during those five months for work in the field of fuel utilization. It possessed all the marks of advanced work in which the students could take part, and was the very beginning of much that followed in that same field.

"A few feet to the west of the Mechanical Building stood the first University boiler house, built at the same time as University Hall. It contained a small 30-horse-power return tubular boiler, which was out of service, and two 100-horse-power Babcock and Wilcox water tube boilers which had been installed in 1890 to furnish steam for power and heating to the electrical, mechanical, and chemical buildings, and to University Hall. New buildings on the campus made more heat necessary, so the Board of Trustees on May 3, 1892, had authorized construction of a new boiler house at a cost of not more than $30,000. The new boiler house was located north of the Mechanical Building, and in it were installed two 150-horse-power Babcock and Wilcox water tube boilers equipped with Murphy Smokeless Furnaces or stokers, capable of burning pea and slack bituminous coal."

In Professor Hitchcock's words, "The year 1894-95 was a most unfortunate one for the Mechanical Engineering Department and its students. On account of a physical breakdown, Professor Robinson was granted a leave of absence for the year, necessitating a division of his heavy class work among three instructors. Professor A. L. Williston, Director of Industrial Arts, was assigned the classes in thermodynamics, prime movers, machinery and millwork, and technical drawing. Assistant Professor H. C. Lord took mechanics and strength of Materials. Assistant Professor Hitchcock, beside being responsible for all laboratory instruction and representing the Department as acting head, assumed invention and design and mechanism. The work of the Department went forward as well as possible under these handicaps.

"Evidently the newly equipped laboratory appealed to many students, for in the fall term, 1894, there were enrolled twenty-one students of electrical engineering and six of mechanical. For the winter term there were eleven students of civil engineering, seven of mechanical, and one electrical. For the spring term there were eighteen electricals and eight mechanicals, making a total of seventy-two students in the laboratory for the year. The year's appropriation for apparatus and supplies was $200.

"Even with the new equipment in the laboratory, apparatus which was in practical use had special appeal for instructor and students; consequently advantage was taken of the opportunity to test some pumping equipment of the city of Columbus. At the East Side pumping station near Alum Creek were two fine Holly triple-expansion pumping engines which attracted the mechanical seniors. Consequently, one day in May, after some street car travel, tramping across fields, and climbing fences, loaded with apparatus, they arrived at the pumping station. There they conducted a standard ten-hour duty test which, in the opinion of the students was a fine example of the real thing.

"That the work of the Department for that year was carried through in a satisfactory manner is evidenced by the report of President Scott in June, 1895:

> In the absence of Professor Robinson on leave, the duties of the laboratory in mechanical engineering were performed by E. A. Hitchcock, Mechanical Engineer, Ass't. in the department; the class in thermodynamics, prime movers, and machinery has been taught by Director Williston; and the class in mechanics has been taught by Henry C. Lord, Bachelor of Science, assistant in mathematics and astronomy. The work in each case was capably and faithfully performed. The return of Professor Robinson with restored health will be eagerly welcomed, and I trust that it will be long before the University is permanently deprived of his eminent ability and service.

"Those of the engineering faculty who had cooperated with the Department and carried on the class work of Professor Robinson during 1894-95 were greatly surprised to learn that their assistance was needed for another year. The year's leave of absence for the Professor did not accomplish what was hoped for, and since his outside interests continued to be quite pressing he submitted his resignation in a letter to the President July 22, 1895, much to the great regret of his students and of his assistant. He wrote:

> ....I have felt unsettled in this matter for over a year, at the same time experiencing an uneasiness by reason of my duty to the University.
>
> I exceedingly regret to relinquish my work in the University on account of my delight in it, & yet my interests in matters outside the University have so grown upon me by reason of my inventive proclivities that I feel that one or the other should be dropped or diminished to avoid overwork. I received a "warning" a year ago, & was given a year off from University work, for which I am under lasting obligation to the Trustees.
>
> I now feel unusually well, but dread taxing work, & as my outside affairs are pressing, apparently important, & finally not inclined to relieve me, I feel that to give my answer now, however much I regret it, I must urgently ask that I may be entirely relieved from further duty in the University......"

One of the consequences of Professor Robinson's resignation was the appointment of Horace Judd as a fellow in the department. Mr. Judd had pursued experimental work and Professor Hitchcock felt this background would be particularly helpful.

In 1894, Professor Robinson was listed as on leave due to his health, and he officially resigned in the summer of 1895. We may wonder whether or not what had actually transpired to precipitate the departure of Professor Robinson was that after having been associated with The Ohio State University for twelve years he was never offered a raise in salary (he could have doubled his income in industry at any point along the way, but chose to remain in teaching) but in fact was offered a 10% cut in pay by the Legislature as a result of economies effected by the panic of 1892. Professor Robinson's patents were providing income at this point, and his services as a consultant were in great demand by the thriving railroads, making the acceptance of a salary cut after so many years of constructive dedication seem ironic. We can only surmise what his feelings were toward the Legislature, but we have ample proof that his loyalties remained with the faculty and students of the Mechanical Engineering Department as he subsequently donated a $5000 testing boiler and endowed with $6850 of his personal funds the first fellowship at OSU in graduate education paying a stipend large enough for a student to live on without outside work.

For those who are history buffs, when Professor Robinson first came to Columbus he lived at 1205 North High Street at the southwest corner of Fifth and High. The house has been torn down and replaced by a drug store and ice cream store. He then moved to 1353 Highland Street in 1889. This house is still standing and it is a delightful Victorian brick with an Oriental touched carpenter Gothic overlay. In 1893, Highland Street could have been called faculty row with Nathaniel W. Lord, Professor of Mining and Metallurgy living at 1175 Highland Street; David S. Kellicott, Professor of Zoology and Entomology at 1332 Highland; and David F. Pugh, Professor of Equity Jurisprudence at 1320 Highland Street in addition to the Robinsons.

A tax of 1/20th mill was passed by the Legislature to support the University in 1891. That there was a financial crisis of sorts in the University around the year 1892 is testified to by the Reports of that year. California is pointed to for having had for some years a millage of 1¢ on the dollar to support its educational facilities.

The following tabulation is included for comparison with other schools benefiting from the Land Grant Act of 1862.

SCHOOL	Last Year's Income	Building Value	Equipment & Apparatus
U. of Wisconsin	$212,000.	$1,000,000.	$200,000.
Cornell U.	521,133	?	573,000.
MIT	235,236	834,933.	?

SCHOOL	Last Year's Income	Building Value	Equipment & Apparatus
U. of Calif. (Berkeley)	236,431.	2,842,013.	300,000.
U. of Illinois	216,628.	500,000.	250,000.
OSU	130,795.85	1,565,000.	79,000.
U. of Minnesota	170,000.	609,500.	174,500.
U. of Iowa	115,000.	279,850.	
U. of Michigan	347,255.	924,400.	92,400.
Yale	500,000.		
Harvard	1,000,000.		

It is pointed out that states far poorer than Ohio are spending more money to educate their youth.

From President Scott's Report to the Trustees, "The enlightenment and generous action of former legislatures has indeed added greatly to the resources of the university; but their liberality, while it met in a measure the immediate necessity, falls far short of the needs that have since arisen... What has been done is only a beginning, but it is bursting with promise... The homes of Ohio have opened and have poured us out a blessing that here is not room to receive it. Hundreds, thousands more will come... More buildings must be erected. More apparatus must be provided. New laboratories must be opened. A great library must be built up. There is no retreat. The state has begun a great work and she cannot abandon it without infidelity to one of her holiest trusts...the obligation to promote the welfare of those who are governed."

In 1896, Ohio State honored Professor Robinson with the honorary degree of Science Doctorate and from 1900 to his death in 1910, he held the rank of Emeritus Professor of Mechanical Engineering at The Ohio State University.

PROFESSOR MAGRUDER ACCEPTS THE DEPARTMENT CHAIRMANSHIP (1896)

Professor Robinson's formal resignation came in the late summer of 1895, and Professor William T. Magruder of Vanderbilt University, Nashville, Tennessee, was elected to take the place of Professor Robinson beginning September, 1896. Professor Magruder received his Mechanical Engineer degree (Professor Robinson's degree was Civil Engineer - naturally - as he was the innovator of mechanical engineering) from Stevens Institute of Technology in 1881. He was a student in Machine Design and Shop Practice, Taunton, Massachusetts, from 1881-1886 and in Chemistry and Mathematics, etc., at Johns Hopkins University from 1886-87. He then was Professor of Mechanical Engineering (practical and theoretical) at Vanderbilt University from 1887 to 1896 when he came to Ohio State.

Once again an insight can be gained into the nature of Professor Magruder by noting excerpts from the correspondence of that time. President Canfield to Professor Magruder, November 11, 1895:

> The chair of Mechanical Engineering at this University is vacant because of the resignation of Professor Robinson. I am informed that you might wish to consider this vacancy with a view to becoming an applicant for the position...The present salary of the chair is $2,250...

Magruder to Canfield, February 1, 1896:

> ....I have decided to ask you to nominate me to the Board as Professor of Mechanical Engineering. To speak frankly & confidentially, I have hesitated only on the score of finance. First, as to what appropriations--special & general--I could expect during the next few years with which to build up the school to the grade of the other departments of the University, & to increase the efficiency & thoroughness as is necessary in order for it to take rank among its competitors in other states; and, second, as to how soon the Trustees could be induced to redeem their pledge, & increase the salaries of professors to $2,500.00 or $3,000.00.....I feel sure that you will not allow Ohio to lag behind the other state institutions, nor expect laboratory work to be done with inadequate apparatus, & professors to live on salaries smaller than are paid at other colleges of like grade, & be contented.....

Canfield to Magruder, February 13, 1896:

> It gave me great pleasure to wire you last evening that you had been unanimously elected to the full chair of Mechanical Engineering. The salary is $2,250 per annum, payable in ten equal payments. Work and salary to begin September 1st, 1896. Secretary Cope will send you official notice today....

Magruder to Canfield, March 25, 1896:

> ...I am particularly anxious that the Engineering Faculty shall make a rule that one exercise of 3 hours devoted solely to practice shall count as the equivalent of one recitation--two hours in preparation & one in recitation. This is the usual practice in technical schools, I believe. It gives great flexibility & holds the professor down to maximum of assigned work, yet allowing him to claim 3 hours of the student's time either in practice or in recitation as he may deem wiser....
>
> ....I am particularly desirous that a locomotive & railroad laboratory shall be started just as soon as the funds will allow it, and trust that Sept. 1897, will see the same begun. I mention these things now, & hope that an As't Prof. of Mechanics may be added to the Corps.
>
> ....When does the renting season begin?....We will need only a small house, 2 or 3 bed rooms, bath room, parlor, dining room kitchen & servant's room, say 7 or 8 rooms as a minimum....

Canfield to Magruder, April 3, 1896:

> Have you any objection to our giving Hitchcock the title of Associate Professor of Applied Engineering?
>
> What title and place, if any, do you desire for Mr. Williston? He will have practically nothing to do outside of your department.
>
> I hope you will arrange your work so as to give each of these men the equivalent of fifteen hours work each week. Generally speaking, two hours in the laboratory will equal one of these "hours" to which I refer.

Magruder to Canfield, April 6, 1896:

> ....Engineering being an applied science, the question would naturally be asked what we mean by "Applied Engineering." I know of none of the colleges which use the title. Mr. Hitchcock is at present, I believe, As't Prof. of Mech. Eng.; if a change of title is thought desirable, I would suggest "Associate Prof. of Experimental Engineering," as his work is along that line. Incidentally, I would ask what distinction is made between Associate & Assistant Professors in grade & salary.
>
> As to Mr. Williston....if agreeable, I would suggest that he, instead of Mr. Swartzel, take the subject of Mechanics (6) and (7), 5 hrs., 3 terms; & that his title be "Prof. of Applied Mechanics & Director of Shop-work." This is on the assumption that his present title, "Industrial Arts," is to be discontinued, & that it is the equivalent of a full professorship. With this arrangement we will all have an average of 15 hrs. a week, according to the proposed schedule....

Professor Hitchcock's notes tell us more of his memories of these early days.

"During 1895-96 there had been considerable activity just north of the Mechanical building in the erection of the first real university power house, a brick structure 40 feet by 60 feet on the inside and 22 feet in the clear. This building with its storage reservoir for condensing purposes and fire protection, along with the new boiler house, was the heart of one of the best heating and lighting systems connected with a university in the United States. William C. McCracken, chief engineer in charge, deserves credit for its design and its successful operation for many years.

"Building this power plant and the installation of its equipment made available additional floor space in the Mechanical Building. The McEwen compound engine was transferred to this plant and a Watertown tandem compound engine replaced the Buckeye 100-horse-power simple engine which, since 1893, had occupied the southwest part of the Mechanical Building. Something over a thousand square feet of floor space could be used for the machanical engineering experimental laboratory.

"With the entrance of Professor Magruder upon the campus in the late summer of 1896, matters relating to the Mechanical Engineering Department began to shape up for the beginning of the new college year. The first move was to establish the headquarters of the department which, for the past two years, had been in the single recitation room on the second floor of the Mechanical Building--a room Mr. Hitchcock had used for a combined recitation, designing, conference, and office room. Professor Magruder was given ample office and recitation room space in Hayes Hall.

"With the coming of Professor Magruder and an appropriation of $3,000 for additional equipment, 1896-97 was a very active year. Professor Magruder began the development of an internal combustion section in the laboratory; he was particularly interested in that field. The space previously occupied by the Buckeye steam engine and its generator was utilized for this purpose. The beginning of the equipment was the Otto gas engine that had been purchased twenty years before for the Physics Department, and a Brown gas engine made in Springfield, Ohio.

"One marked improvement in the laboratory during 1896-97 was the tearing out of the two brick walls in the north wing, making one large steam and hydraulic room 90 feet by 30 feet.

"Continuation of healthy appropriations by the Board of Trustees, in amounts ranging from $3,000 to $5,000 over a period of six years made it possible for the Department to build and maintain an exceptional experimental laboratory....In the west room was built a machine shop and also a place to maintain tool orderliness. In the north room much equipment was added for work in steam and hydraulics. Several important items were a tandem compound duplex steam pump of large capacity, a simple outside packed plunger pump from the service department, and a 35-horse-power simple steam engine--to which was connected a new surface condenser--from the Electrical Department. Additions for hydraulics included a belt-driven triplex pump, a venturi meter, and a large impulse water wheel. A large concrete bay was constructed along the east wall for a stand pipe and turbine water wheel, with necessary weirs, gauges, etc.

"Professor Robinson, in originally equipping this laboratory in 1893 for the advanced work of the department, had introduced several features which were new in laboratories of this character. Outstanding was the stand pipe for studies on flow of water under different pressure heads. The first stand pipe installed was 24 inches in diameter and 24 feet high. It was capable of producing equivalent heads of water up to 200 feet by means of a closed head at the top having a vent connection with accessible valve control.

"The investigation of the Murphy Smoke Consuming Furnace installed in the new boiler house and reported on in May, 1893, by Professor Robinson and W. C. McCracken proved to be only the beginning of many fuel and boiler tests with power plant equipment conducted by the department under the supervision of Mr. Hitchcock. In this work Prof. N. W. Lord, head of the Department of Metallurgy, became greatly interested.

"For years Professor Lord had been making chemical analyses of coals, and was well known as an authority in that field. In teaching the use of fuels in blast furnaces, roasting ovens, boilers, and similar apparatus, he had developed a form of heat balance which was quite new in boiler testing at that time. The Mechanical Engineering Department recognized its value and adopted it, using it for the first time in January, 1895, on the investigation of Hocking and Thacher coals.

"Although Professor Robinson resigned from the University in 1895, his interest in the activities of the Department of Mechanical Engineering continued during his lifetime through his intimate association with Mr. Hitchcock.

THE ROBINSON GIFT OF A STEAM BOILER

"Professor Robinson always was interested in the efficient utilization of fuels, and therefore recognized the importance of having an independent unit for making tests in this field. His particular interest resulted in a gift on his part to the department as set forth in his communication of January 20, 1900, to the Board of Trustees."

> I have become exceedingly interested in the testing of boilers and fuels at the university by my former assistant, Professor E. A. Hitchcock, by reason of the unusual and high value of the results obtained.
>
> I may say that I have discovered such ability and enthusiasm in the professor in connection with these tests as would enable him with an especially equipped boiler to reach results of hitherto unknown importance.
>
> With this in view, it will be my greatest pleasure to donate to the university, a special testing boiler peculiarly adapted for all such high class and varied work.
>
> With the Multiplex boiler I propose, Prof. Hitchcock can make tests representing a dozen different first-class boilers in use to-day, and including a possible twenty, giving the same results for each as if they were set up in our boiler plant one after another and tested.
>
> A series of such testing would attract attention to the university and widen the knowledge of her as a source of such information, and also influence the youth in his leaning toward the institution of learning.
>
> I therefore offer for your acceptance as a gift from your former servant, the iron work of such a boiler, which after much study is believed to be the most complete one in this country, its varied accessories being shown in the accompanying drawings and specifications.

I wish to call attention to the high class work in analysis of fuels rendered heretofore by Professor N. W. Lord, as well as to Professor Hitchcock, and to thank him sincerely; and to extend to him a special invitation to aid us in the future tests with the new boiler. With due consideration and thanks from us all.

Very respectfully, your obedient servant,

(signed) S. W. Robinson

SPECIFICATIONS

For experimental boiler and its equipment, to be donated by Professor S. W. Robinson:

One 107 H.P. Babcock & Wilcox boiler, wrought steel construction throughout, capable of carrying a working pressure of 200 lbs.

One Green's fuel economizer for heating the feed water by means of the escaping flue gases; 575 sq. ft. heating surface.

One air heater for heating, by means of the escaping flue gases, the external air supplied to the fire. This contains about 305 two-inch tubes, 8 feet long, giving heating surface of about 110 sq. ft.

One forced draft fan, for drawing air through heater and from boiler room and supplying same to fire. In addition the fan will furnish such draft as is necessary for varying degrees of combustion.

One induced draft fan for producing any practical amount of draft independent of stack or chimney.

Equipment will have at least twenty possible combinations meeting every condition found in practice for the particular style of boiler.

Professor Robinson's proposal was accepted in the following action:

RESOLVED, That the tender of a test boiler by Professor S. W. Robinson, emeritus professor of mechanical engineering, be accepted with the conditions stated in his communication, and the Board of Trustees hereby extend to Professor Robinson their hearty thanks in behalf of the university and the state for his generous gift.

RESOLVED, That the installation of the apparatus be referred to the president of the university, Professors Robinson, Magruder, Hitchcock, and the chief engineer, Mr. McCracken, as a special committee with power to carry the same into effect.

RESOLVED, That the secretary be instructed to present to Professor Robinson a copy of these resolutions.

This boiler and equipment were furnished by the builders at special discounts for educational purposes at a total cost to Professor Robinson of $2,001. The real value was $3,569. The committee report adopted by the Trustees indicates the cost to the university of installation and accessories:

Columbus, Ohio, February 28, 1900

Rev. W. O. Thompson, D.D., President O.S.U.,
Columbus, Ohio:

Dear Sir-

It has been decided after conference that the new boiler recently presented to the university shall be located for the present in the boiler house and that the following expenditures are necessary:

Foundation for the boiler, pump, engines, etc.	
Masonry for the boiler and accessories	
Piping to and from the boiler,	
Erection................................Total	600
Two water weighing tanks.................	50
$1\frac{1}{2}$-inch pipe line for 200 lbs. pressure to the mech lab..........................	150
Miscellaneous expenses, cutting flues and walls, etc.	75
Side walk between bldgs., mech. lab, and boiler house	25
Pyrometers, thermometers, etc...........	200
	$1,000

During the year 1900, this experimental boiler was erected as authorized in the main university boiler house. The annual reports for that year referred to it as follows:

From the report of Secretary Cope:

Among the important acquisitions during the year was the gift by Doctor S. W. Robinson of an experimental boiler and the machinery and appliances necessary for making accurate tests of boilers and fuels under varying conditions.

Doctor Robinson was led to make the donation, as stated by him in a letter addressed to the Board of Trustees, by his interest in the tests of boilers and fuels made at the University by Professor Hitchcock, his former assistant. The gift was made on the condition that the trustees should assume the cost of installation, and was gladly accepted....

Dr. Robinson afterwards added to the gift a steam engine for driving the economizer and the necessary iron work for connecting up the fans. The value of the gift is near $3,000. The apparatus has been installed at a cost of $885.78, and the boiler has been connected with the general heating system for use in emergencies at a cost of $131.33. Dr. Robinson served on this committee having charge of the installation, gave every detail careful attention, and rejoices with the University authorities that the institution has the most complete plant of its kind in existence.

From the report of President W. O. Thompson:

> During the current year, Professor Stillman W. Robinson, whose timeof service dates from 1878, has made a generous contribution to the department in which he has served so conspicuously. By adding to the equipment for experimental engineering one of the best appointed testing boilers manufactured, Professor Robinson has not only greatly increased the facilities for work, but has earned the grateful recognition of the University for his generosity.

Professor Hitchcock continues his discussion. "The Robinson Experimental Boiler located in the west end of the University boiler house had all the advantages as to education, experimentation, service to the university, and details in operation which such a location would naturally give. Here was a most unusual plant consisting of a standard water-tube boiler but erected in such a way as to offer many combinations of operation. The furnace was of the Dutch oven type, hand fired, especially adapted to the burning of bituminous coals for best efficiency. For determinng possibilities of increased efficiency by utilizing the heat in the products of combustion after they leave the boiler, there were the economizer to cause this heat to pass to the water entering the boiler and the air heater to cause its absorption by the air supplied to the furnace. This combination required a forced draft fan, drawing air from the room through the air heater and blowing it into the furnace ash pits. An induced draft fan located above the boiler produced any practical draft desired, discharging the products of combustion direct to the atmosphere and thereby making possible independent and accurate smoke observations, highly desirable in the testing of fuels. The arrangement of this plant was such that it could be operated at any time on the natural draft produced by the university chimney or stack, and also could be used to supplement the steam generation of the university boiler plant."

This experimental boiler first went into operation in February, 1901, for a thesis investigation entitled, "The Effect of Economizer and Air-heater on Boiler Efficiency" by A. J. Boehme, G. R. Bott, and J. S. Wilson. The results of this study, along with thirteen other investigations, were presented at the June 1903 meeting of the American Society of Mechanical Engineers by E. A. Hitchcock.

For seven and one half years this Robinson test boiler occupied this location, and during that period one hundred and sixteen boiler and fuel investigations were made by means of it. In the fall of 1908 it was given a permanent location in Robinson Laboratory, with some modifications and additions which are referred to in the description of that building and equipment.

During this growth period almost any piece of equipment was acceptable, no matter what its age and condition, if it could be put into suitable shape for investigation purposes. Antiquated apparatus, however, was not in keeping with a progressive department. Consequently, Professor Magruder decided that the department should design a real experimental engine having many possibilities, and that as far as possible it should be built in the shops of the Department of Industrial Arts. With this position the other staff members of the Mechanical Department, consisting of Associate Professor Hitchcock and Mr. Horace Judd, who was appointed in 1897-98 as fellow and laboratory assistant, were in hearty accord. The professor took upon himself the responsibility of the design of such a unit (which in time would be known to many as "Maggies Folly.").

For the year 1898-99 the department was allowed an additional fellow, and F. J. Hale, a graduate of the class of '98, was selected. The compensation was $300 for the year. Mr. Hale held this position for two years, devoting the major part of his time to the design of the proposed experimental engine which became a reality in December 1903. It was erected in the north end of the laboratory. During that school year Messrs. W. J. Gould, T. W. Holloway, and J. M. Lampert conducted upon it an elaborate series of tests for their graduating thesis. In this thesis this unit is described as follows:

> The engine tested is a vertical experimental tandem steam engine, 4-1/2" and 10" x 6" in size. It is the conception and design of Professor Wm. T. Magruder. All the drawings, and many of the details of the design were made by Mr. Fred. J. Hale, M.E., O.S.U. '98. All of the patterns, and all of the foundry and machine work, with the exception of a few of the parts which were too large for the University shop tools, were made in the Department of Industrial Arts. The bed-plate was cast and finished at the works of the Columbus Machine Company. The low-pressure cylinder was cast at the P. Hayden Saddlery Hardware Company, Columbus. The crankshaft was forged by Joseph Dyson & Sons, Cleveland, and machined by the Columbus Machine Company. The connecting rod was forged by Joseph Dyson & Sons, and machined by the W. D. Forbes & Company, Hoboken, N.J. The flywheels and outboard bearings were obtained from the Dodge Manufacturing Company.
>
> The engine is designed for experimental and educational purposes. It is the inverted, vertical, or steeple type of steam engine, with steel rod frame. It has a center crank with two main bearings on the bed-plate, and an outboard bearing on each side. The cylinders are arranged with the large or low-pressure cylinder below and nearest the crank, and the high pressure directly above. Valves are provided so that the engine can be run tandem-simple or tandem-compound as desired. Either cylinder may be run separately, the piston and valve gear of the other cylinder being removed; and condensing or non-condensing, each cylinder being connected separately both to the atmosphere and to Wheeler surface condenser and Blake air-pump.
>
> It has a slipper cross-head and guide and a forked connecting rod. Both cylinders are equipped with the Meyer Expansion Valve gear, so that any cut-off desired can be had in either cylinder. The main cut-off valves are worked from eccentrics on the outside of the main bearings, and the engine is provided with a Stephenson link motion, which can be easily attached, but was not used in this series of tests. The riding valve of each cylinder is worked from a single eccentric, and can be used or taken off entirely as desired.

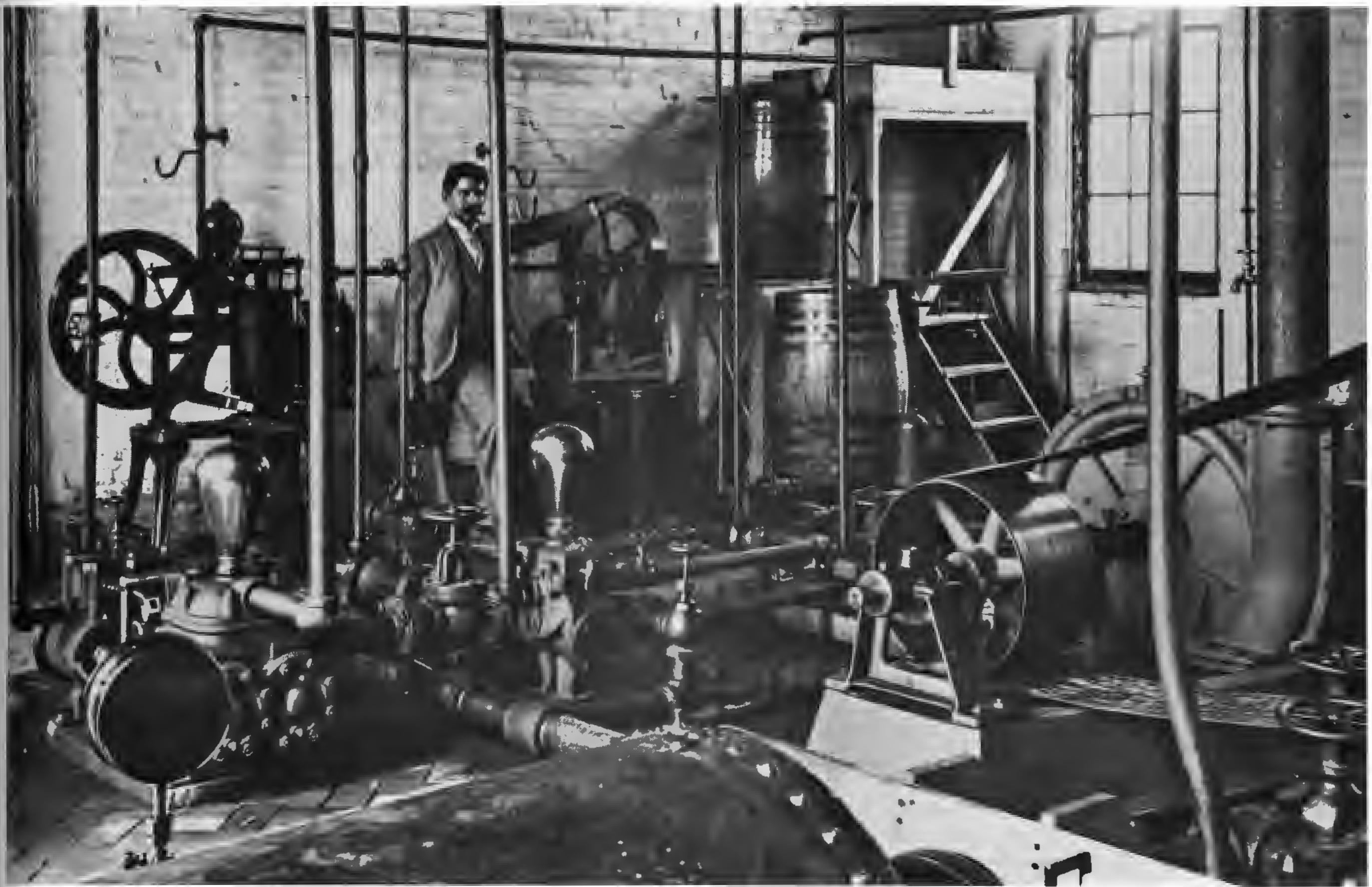

Figure 7. Charles Martin is shown in the Hydraulics Laboratory in 1900. This was the laboratory which was first built up by Horace Judd and then later updated and improved by S. Beitler.

Figure 8. This is the mechanical engineering machine shop as it appeared in 1905. Much of the extensive belt system was devised by Professor Robinson. The location was in the first mechanical engineering building.

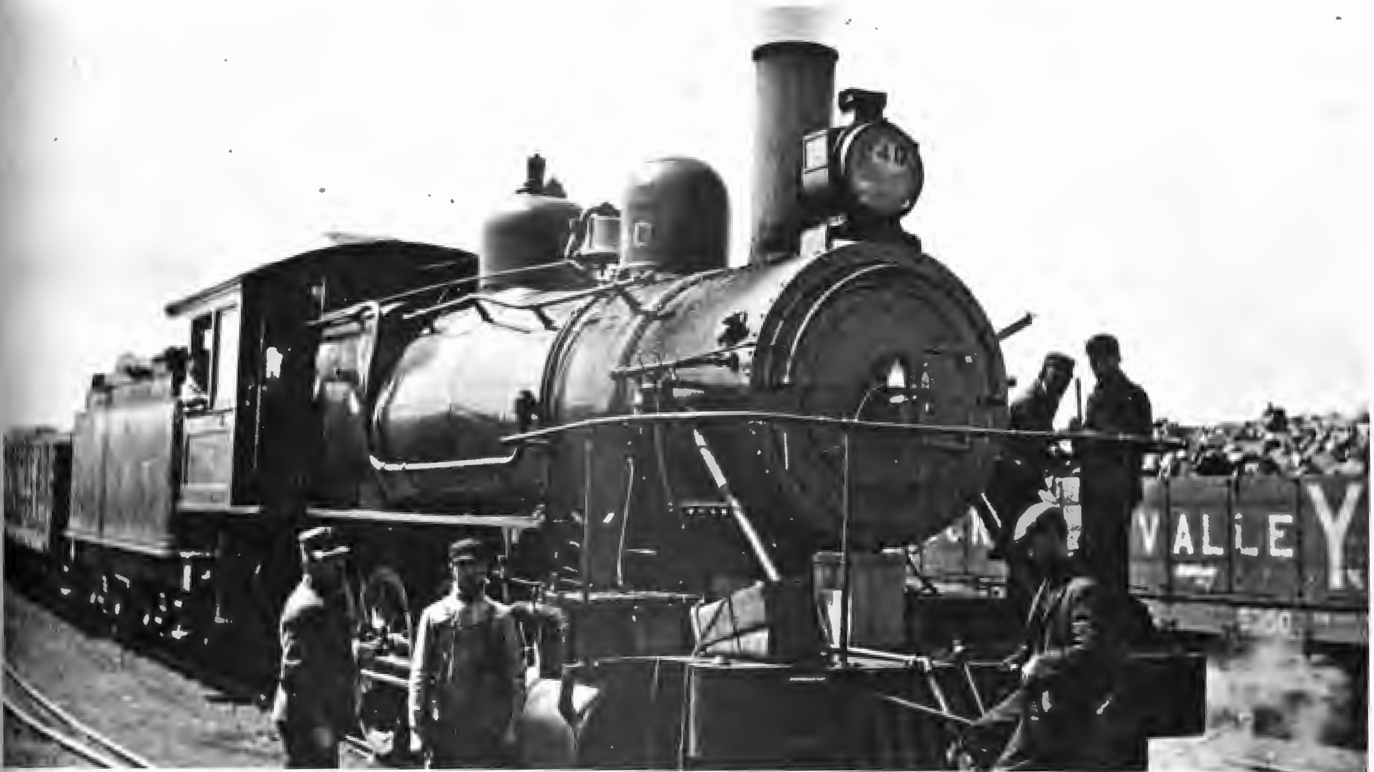

Figure 9. Early Railroad Research - a Hocking Valley railroad freight locomotive in 1902. The testing crew (left to right) R. E. Rightmire, E. G. Bailey, E. A. Hitchcock, H. E. Williams, and W. A. Johnson. Tests like this helped to inspire E. G. Bailey to a career which has contributed greatly to the welfare of mankind. He founded the Bailey Meter Company and through his many patents accelerated the development of central power stations which could provide electricity to rural as well as urban areas.

Figure 10. On January 20, 1900, Professor Robinson wrote to the University Board of Trustees and offered the above boiler as a gift. His continued interest in the Mechanical Engineering Department and his interest and high regard for his colleague, Professor Hitchcock, along with the conviction concerning the importance of independent tests in the utilization of fuels is demonstrated by this gift. It is particularly noteworthy that, although during his tenure at The Ohio State University, Professor Robinson went through the country's economic depression in the 1890's and spent many years without a raise in his salary and in fact an attempt was made to cut his salary, he still remained loyal to his adopted university and made a gift which cost him $2,001. He later gave the department a steam engine which cost about $3,000 and later added funds for the Robinson Fellowship which is permanently endowed.

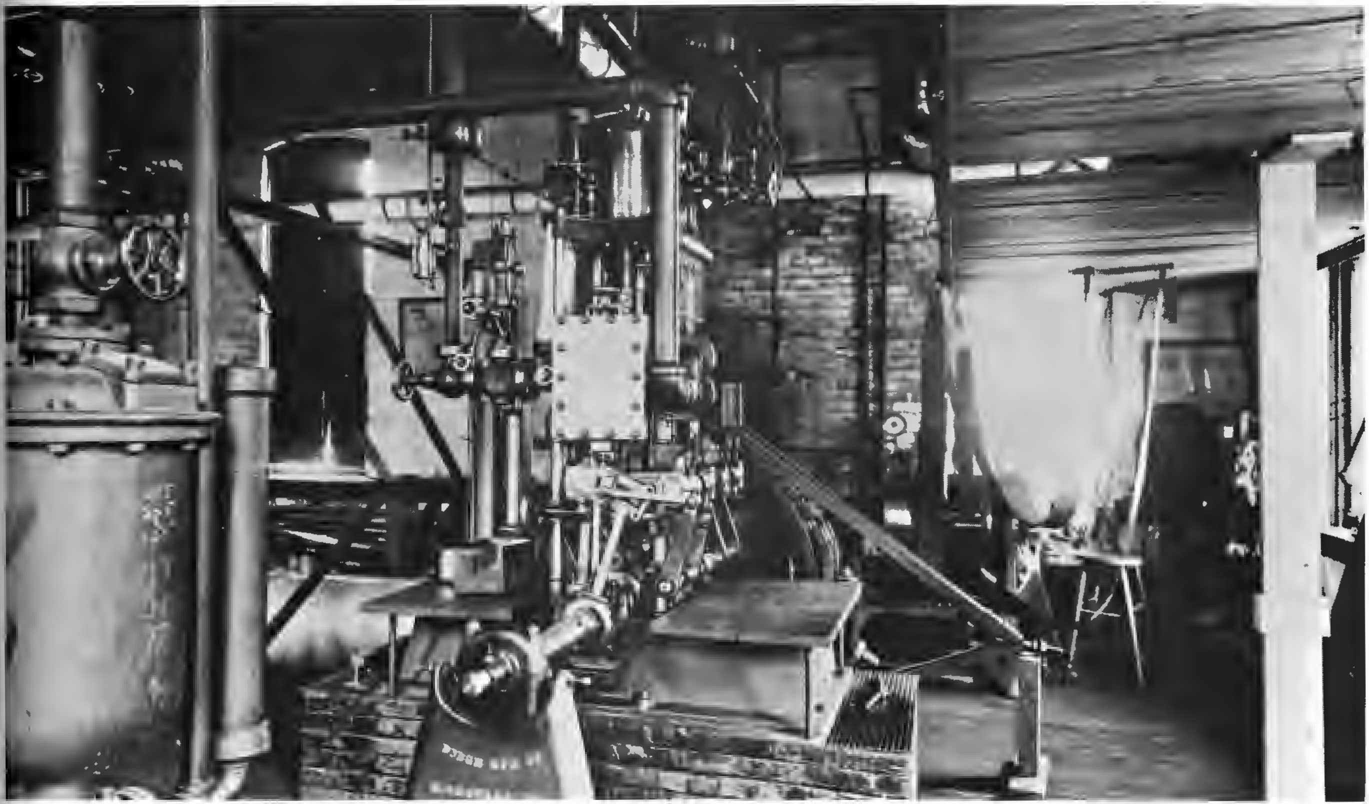

Figure 11. The vertical experimental tandem steam engine designed by Professor Magruder and built with the aid of students, in particular Mr. Fred J. Hale, ME '98, and various university shops. This engine, which was completed in 1903, became known as "Maggies Folly" since it incorporated great flexibility in operation. Either cylinder could be run separately, it could be run condensing or non-condensing, and many other variations.

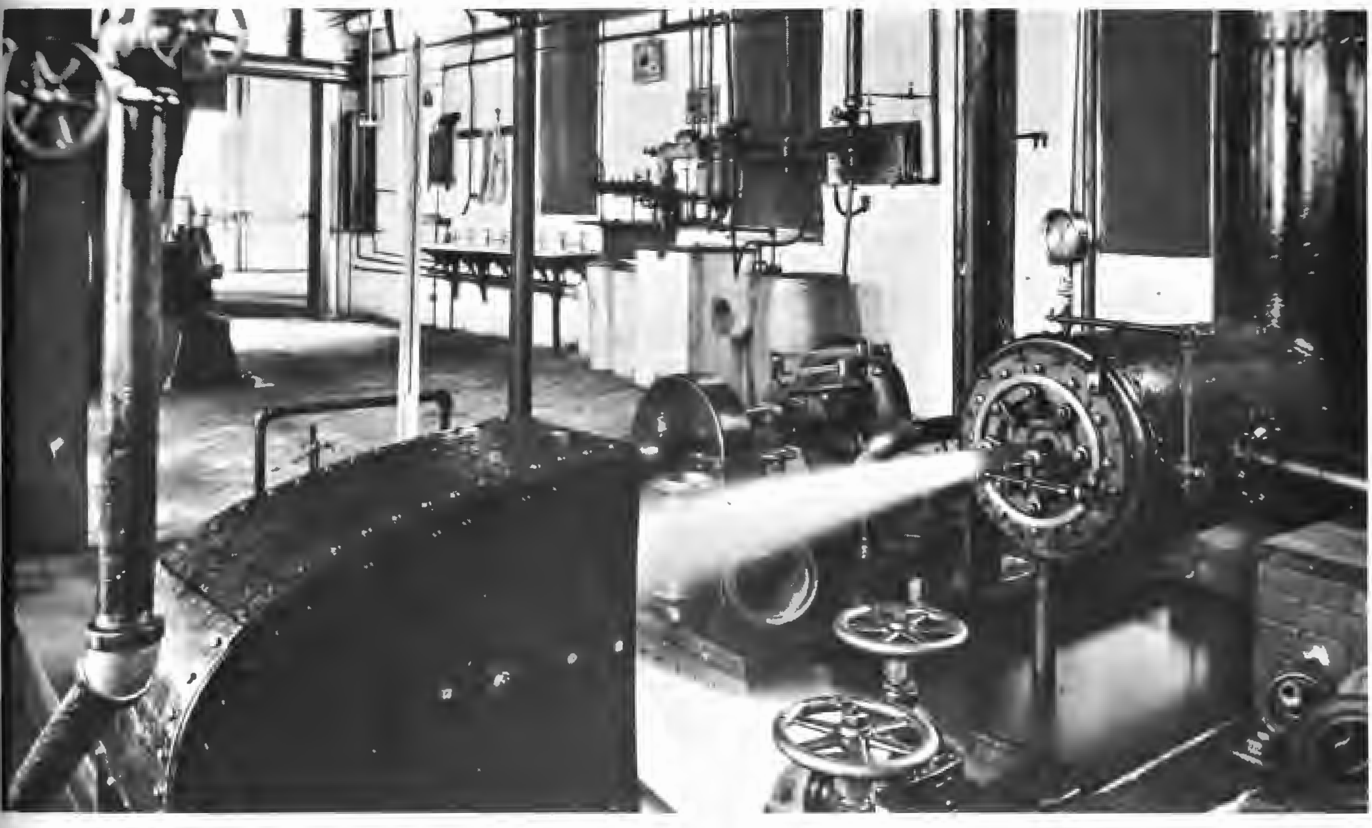

Figure 12. Orifice calibration in the Hydraulics Laboratory in 1900. The laboratory appearance has changed but the department still provides the service of calibration of fluid metering devices for industry both local and foreign. Flow meters are now calibrated to better than ±0.25%.

There are two flywheels, one or both of which may be used. Also two different sets of crankshaft counterbalance weights. By these means, various combinations can be arranged. Steam is admitted to each cylinder from the main steam pipe through separators made by the Direct Separator Company, of Syracuse, N.Y. The engine was designed to use steam at 150 pounds boiler pressure, and to run at a maximum speed of 400 R.P.M.

THE MECHANICAL ENGINEERING DEPARTMENT (1901 Catalogue Description)

The greater part of Mechanical Hall is devoted to laboratory purposes.

The south laboratory is used for applied mechanics and for gas engineering. Here are located the machines for testing the strength and elasticity of engineering materials, and recording their physical properties automatically and autographically. Oils are tested as illuminants and as lubricants. Belts and pulleys are tested for their slippage, friction and horse-power transmitted. The gas engine plant has three engines, representing gas and gasoline, three methods of ignition, and flyball and inertia governors. The air is supplied by a fan through a large meter. Temperatures and pressures of air, gas and water are measured. The fresh and burnt gases are analyzed and their heating values determined by a calorimeter. The power is measured at both the indicator and the brake. The laboratory machine shop and tool room are in this room.

The north laboratory is used as a steam engineering and hydraulic laboratory. Four 35-horse-power engines give facilities for testing single and duplex condensing or non-condensing, simple or compound, throttling or automatic cut-off engines, using either a jet or a surface condenser. Pressure and vacuum gauges are calibrated. Indicator springs of five makers are tested either cold or hot. Five kinds of calorimeters determine the moisture in steam before and after passing three different separators. Injectors are tested for lift, quantity, pressure and steam consumption. Steam pumps of six makes, ranging to 800 gallons per minute capacity, two centrifugal and a rotary pump, enable tests of pumps to be made and deliver water at pressures below 150 pounds to two stand-pipes, which in turn supply turbine and cascade and Pelton water wheels, and enable experiments to be made on the flow of water through orifices, pipes, valves, etc. Three cisterns provided with a variety of weirs up to five feet wide, give practice in measuring flow water. A Venturi meter and a Pitot tube are also used. Ericsson and Rider hot air engines are tested. A Rife hydraulic engine, a Humphreys ram, Gem and Eureka water motors, and a pulsometer, are included in the hydraulic apparatus, all of which are connected and prepared for complete tests.

A complete set of Westinghouse air-brake apparatus, a blower and a ventilating fan, enable experiments to be performed in the flow of air. They are supplemented by tests of the heating and ventilating plants in the buildings of the campus.

In addition to the apparatus and equipment of the power plant of the University the power house at Townshend Hall contains a horizontal, return tubular boiler, two steam engines and an ammonia refrigerating machine, making the facilities on the campus for testing quite complete. Machinery, apparatus and appliances are continually being presented, built or purchased, and the student is given an opportunity to test everything under practical conditions of operation. Besides the laboratory facilities, opportunities frequently arise to test machinery, engines or boilers in the city, and in these tests the students take part.

The buildings of the power plant were completed in 1896, and, with their contents, form a model plant. The boiler room is 38 by 100 feet, and is equipped with five 150 H. P. boilers, with Babcock and Wilcox chain grates and Murphy automatic stoker. There are also coal and ash conveyors for the whole plant. At one end of the boiler room is the coal room, and at the other the pit for the hot well, from which runs the tunnel (about three-fourths mile in length) to the buildings of the University, carrying heat, gas and water-pipes and power, light and other wires.

Near the boiler house is the power house, 40 by 60 feet. The power generating plant consists of a 70 Horse Power McEwen compound engine, belted to a 60 kilowatt 2-phase Westinghouse Alternator, and a 200 Horse Power Watertown Compound direct connected to a 125 kilowatt 2-phase generator. These occupy the main floor, together with a complete marble switchboard, with ammeters, voltmeters, wattmeters, static ground detectors, etc. A ten-ton traveling crane is available for handling the machinery in this room.

In the basement are condensers, which get their water from a large cooling reservoir at the side of the building. Here also are the transformers that convert the current to be used in the motors scattered over the campus, from 110 volts, at which it is generated, to 400 volts, at which it is transmitted.

There are installed on the campus over eighteen hundred incandescent lamps, twenty-four arc lamps and about 250 H. P. in motors. The electric plant is for the most part of the Westinghouse system. The buildings are of brick. Nearly all of the University buildings are heated by steam from this plant. The total cost of the plant for generation of power, light and heat, and for its transmission to the buildings, has been something over $100,000.

In order to facilitate experimental and research work in the direction of combustion of fuels under variable conditions as applied to steam generation there was installed during the past year in the University boiler house, a most complete experiment boiler outfit. This equipment was furnished by Stillman W. Robinson, Emeritus Professor of Mechanical Engineering, who not only established the Department of Mechanical Engineering at Ohio State University and for many years was its head, but was the originator of the first Mechanical Engineering Department in this country connected with a state university, that at Champaign, Illinois.

A Babcock & Wilcox boiler of 107 H. P., built for a working pressure of 200 lbs., with hand-fired furnace of the oven firebrick type is the principle of the system. The products of combustion, after passing the boiler, can be conducted direct to the open air by the chimney or otherwise, or into a Green's fuel economizer, where its 570 square feet of heating surface transfers heat to the feed water on its way to the boiler. The heat of the escaping gases can still further be absorbed by an air heater having 1,330 sq. ft. of heating surface. The heat thus taken up is transmitted to the air employed in the fuel combustion.

For promoting combustion, natural draft may be employed, or when greater intensity of draft is desired above that produced by the chimney, the latter can be cut out and a Sturtevant induced draft fan, driven by a direct connected engine, brought into action. In combination with either mechanical, induced or natural draft, forced draft produced by a belt-driven Sturtevant fan may be employed, and the air forced into the ash pit may be taken from the boiler room direct, or by a system of underground flues be compelled to pass through the air heater on its way to the fan.

Weighing and collection tanks, in conjunction with a steam pump, supply the boiler with known quantities of water which flows by the way of the economizer or to the boiler direct. In this feed water system is a Hayden's feed water purifier with live steam heater, which may be used in conjunction with the economizer.

Draft intensity and temperatures are determined at many points throughout the system, a Le Chatelier pyrometer being used for high and mercurial pyrometers for low temperatures.

An Arndt's econometer indicates continuously the percentage of carbon dioxide in the escaping gases, while at the same time the Orsat's apparatus is used for giving absolute composition. The composition of the fuels employed and their calorific values are determined in the department of Metallurgy.

The plant as a whole admits of many combinations, thereby being able to meet almost every condition in practice.

Industrial gifts continued to pour in to the Mechanical Engineering Department during the tenure of Professor Magruder. Likewise, students continued to pour in so that by June, 1902, Professor Magruder was forced to report that an engineering building was needed so badly that "we feel disposed to discourage attendance and to recommend our young men to go out of state until such time as Ohio can meet their needs."

The loss of these young men was reflected in this statement from the Trustees Report of that year. "The State has no material resources at all comparable with its citizens and no hope of perpetuity except in the intelligence and integrity of its people." By 1903, the first of three needed engineering buildings was going up.

Once again the mechanical engineering students and faculty came to the assistance of the university when they conducted a cost analysis of the problem of getting coal from the railroad tracks across the Olentangy River to the power plant on the campus. The question was whether it would be less expensive to haul the coal over a bridge by wagon or to erect a sturdy and more expensive bridge to carry the coal by train. The train won, and a spur was put in for the delivery of coal to the power plant.

Prior to this time there had been two chemistry buildings burned with the subsequent reappropriation of mechanical engineering building funds to meet the emergency. February 19, 1904, saw the chemistry building burn again, and once again building was postponed for mechanical engineering and electrical engineering.

An important observation concerning the Robinson years is that many of the students selected areas of investigation which launched them into their professional career. Mr. Hitchcock noted as one example the special student Mr. McEwen. Another outstanding example is the seniors of 1901-02 and 1902-03. Many from this group extended the classroom exercises to field tests using steam railroad locomotives. One group, Mr. E. G. Bailey, Mr. R. E. Rightmire, and Mr. H. E. Williams selected as a thesis topic "Comparative Road Tests of Consolidated Freight Locomotives." The investigations helped to inspire Mr. E. G. Bailey into a career during which time he would found the Bailey Meter Company and contribute greatly, through numerous inventions and concepts, to the improvement of man's standard of living.

Time and space being at a premium, summer shop courses were offered in engineering during the summer of 1904. These proved satisfactory as a supplement to limited time available during the year and were well received by faculty and students.

It was definitely understood at this time that a new building was needed and that this new building should be designed primarily for laboratory purposes, since, as Dean Orton stated in his annual report, the Legislature had provided only sufficient funds to care for about one-third of what was then needed for the two departments. The understanding was that since the immediate structure was for strictly laboratory purposes and, therefore, designed with that objective in view, all offices and museums, recitation and lecture rooms, drafting and conference rooms were to be provided for in the future main Mechanical and Electrical Engineering Building, standing just east of, and running parallel to, this laboratory structure.

In designing this new laboratory, two special major factors had to be considered. One was a saw-tooth constructed roof for north light over the laboratory proper. The other was the need for one large room for experimental boilers, gas producer and internal combustion engines, its width to be forty-eight feet. The laboratory was built with seven bays each thirty feet wide; two, containing the various rooms, twenty-five feet wide; and the forty-eight-foot bay. The total north-south length was 308 feet. The general depth was 112 feet, while the forty-eight-foot bay was 32 feet longer. Because of the extreme width of this bay, its roof design involved a special feature, since two rows of sky lighting were planned with no supporting columns running the length of the room. Upon the advice of Prof. C. T. Morris of the Department of Civil Engineering, the clear span was accomplished by joining up the top junctions of the double row of trusses with stiff compression members. According to Architect Bradford, this saw-tooth type of building was here used for the first time in connection with any university educational building. That design was followed later in the erection of several buildings on the Ohio State Campus.

As completed for the laboratory work in Mechanical and Electrical Engineering, the building was of factory construction with two-story portions at the north and south ends. The walls were of dark red corduroy-faced brick. That part of the roof visible from the front and sides was covered with red tile. The main central part consisted of the bays with saw-tooth roof, giving northern light, supported upon 22-foot columns of sufficient strength for traveling cranes. The balconies were means for entrance to the second-story rooms and served as a direct highway from one end of the building to the other. Balconies along the columns were designed for lines of experimental work not especially suited to the main floor. An amphitheatre type of lecture and demonstration room for the service of both departments was built in the east end of one of the center bays of the building.

The hydraulics and testing laboratory was initiated in approximately 1908 by Horace Judd, then an assistant in the department. This laboratory was further developed and grew into a standards laboratory for orifice testing. We still calibrate metering devices for an international clientele.

THE NEW MECHANICAL ENGINEERING BUILDING COMPLETED (1908)

By the first of January, 1908, the long awaited laboratory building for mechanical and electrical engineering was completed. "When this equipment shall have been completed, the University will have increased facilities for these departments and faculties not surpassed anywhere in the Midwest." This was Robinson Laboratory that we still, some sixty years later, regard as home. The contract let for construction of the building was for $62,597.

Professor Robinson had followed the new laboratory design and construction with great interest. He followed the progress of his old department very closely regardless of the fact that he was retired. The faculty of the university was deeply sorrowed at his death and presented a Memorial service in which Dean M. E. Cooley represented the University of Michigan, Professor I. O. Baker represented the University of Illinois, C. F. Marvin, class of 1883 represented the alumni, and Professor E. A. Hitchcock represented The Ohio State University. A memorial volume was published on this occasion and included are the experiences and accomplishments of Professor Robinson.

In the closing paragraph of Professor Hitchcock's memorial address, he expressed the hope that some day in the future a Robinson Hall would stand on the Campus. That hope was soon fulfilled as on June 12, 1911, the board of trustees of the university took the following action:

> In recognition of the life and service of Stillman W. Robinson, as a man, a citizen, an engineer, and an educator, and in further recognition of the obligation which The Ohio State University owes to his ability, his professional eminence, his profound loyalty, his long service, his not too inconsiderable gifts to its material equipment, and his successful efforts in the stimulation of research in the fields of applied sciences, the Board of Trustees hereby directs that the building used by the departments of Mechanical and Electrical Engineering shall be known as the Robinson Laboratory.

Actual student enrollment - a body count - is frequently a difficult number to locate as the faculty were, and still are, inclined to count the number of students in each course and total the numbers for each course to pronounce a figure reflecting enrollment. This actually is inflated by a factor of anywhere from 3 to 5 and is difficult to work with. During the turn of the century years a body count was available in some instances, and enrollment figures look like this:

Year	University Enrollment	Engineering College	Mechanical Engineering
1896-97	968	313	17
1897	1150	288	12
1898	1149	309	22
1899	1252	391	44
1900	1465	486	
1901	1516	580	
1902	1735	659	
1903	1827	720	
1904	1870	716	
1905	2157	776	
1906	2277	787	
1908	2686	877	
1919	7817	1192	269
1920	8313	1434	318
1921	8850	1489	347

For the year 1904-05 figures were included for comparison of the engineering enrollments at the largest engineering schools.

Attendances of Colleges of Engineering for Year 1904-05

Mass. Inst. Tech.	1561
Cornell	1415
Purdue	1150
U. of Michigan	993
U. of Illinois	909
U. of California	820
U. of Wisconsin	804
OSU	716
Iowa State College	704

These enrollment figures reflect the intense industrialization which was taking place in the country. By 1928, the Dean of Engineering (Hitchcock) was able to report that the numerical position of the College of Engineering places it 4th in a field of 148 schools in the U.S. with respect to 4-year enrollment. It is exceeded by "Purdue University, MIT, and the University of Illinois in the order mentioned." Through the years, Ohio State has generally fallen between 4 and 6. Mechanical and Electrical Engineering have vied with each other over the years for high enrollment - with Mechanical Engineering accounting for about 1/4 to 1/3 the total graduates of the College of Engineering.

Much praise for the growth of Mechanical Engineering must go to the faculty whose lives have been devoted to teaching and research. Today there is much discussion as to the place of research with respect to teaching, and once again history indicates the wisdom of our forebearers. No nonsensical discussion of the value of research to teaching are included in the archives, but research is continually being reported as a function of the university faculty as a part of their normal course of action. That research was of value is testified to by the establishment of the Engineering Experiment Station which was set up to fund research done by the members of the teaching faculty. For this purpose $10,000 per year was initially supplied by the state. By 1920, $20,000 per year was allocated in this fashion. Professor Robinson's own list of publications verifies his views on research and publication and unquestionably his personal renown reflected well upon Ohio State's developing reputation. Professor Magruder points with pride to a paper presented in 1906 by several mechanical engineering faculty members - tacitly recognizing that there was bigotry in science even in that day as he says, "It established new values for old constants and hence was attacked and needed defending. It showed the character of the men and the work done in this department."

Before proceeding and leaving the impression that the faculty in days of yore did all this research out of the goodness of their hearts, it would be wise to point out the basis for all this activity was the tried and proven system of capitalism. While doing all this research the mechanical engineering faculty members were adding to the regard with which the University was held on a local as well as national basis; they were adding equipment from their research to the facilities of the university; they were giving their students first-hand experience at doing something that was of some use to somebody; and last, but not least, they were making money in addition to their salaries for themselves. This latter factor has been changed in recent years and we now do not allow extra compensation for research investigations.

The year 1911 brought with it a reevaluation of the degrees being offered in Mechanical Engineering. First of all, there was introduced an Arts-Engineering course leading to degrees in both areas in 6 years. This was meant to alleviate the stigma of having to change from the Engineering College to the Arts College if the student proved unable to get the mathematics and science. The student would first obtain a four year arts degree and then take two subsequent years of engineering for the engineering degree.

The engineering faculty was indeed dubious as to the value of such a curriculum, and apparently the students were also dubious as it attracted scanty enrollment and eventually died a natural death.

The second major change occured in 1915 and from this year the degree "Mechanical Engineer" was no longer to be awarded for four years work, but was to be reserved for postgraduate work. Henceforth, for four years successful academic work the student would receive a Bachelor's degree in Mechanical Engineering. "The adoption of the Bachelor's degree carries with it by implication the provision of means for students to secure the Master's degree and either the Doctor's degree or the more coveted Professional Degree of Engineer."

Time has altered the degree sequence so that the professional degree is now a terminal degree in most cases. Those interested in this degree prepare for professional practice in the design, development and management of mechanical engineering machines and systems. Those interested in the M.Sc. and Ph.D, degrees prepare for research and teaching as well as some types of high-load design analysis, development and research management.

The rapid industrialization and prosperity prior to World War I changed the status of the graduate engineer. In the 1880's and 1890's graduate engineers were looked upon with some suspicion; Professors Robinson and Hitchcock tell us that often it was necessary to get a job through friends or lacking this contact it was often wise not to admit to having a degree prior to landing the job. The success of the engineers who did graduate is demonstrated by the great demand for these graduates from 1910 to just prior to World War I. The demand was also a tribute to the relevance of their academic programs. This shortage of graduate engineers, the type of professional who can be depended upon to develop useful technical devices and the engineering skills of Professor Hitchcock which kept him so in demand, contributed to the exciting consulting work Professor Hitchcock was able to be involved in. After 21 years with the Mechanical Engineering Department, Professor Hitchcock resigned to accept some of the industrial challenges. His resignation in 1913 left a vacant faculty position and this position was filled by Mr. F. W. Marquis of Illinois.

Mr. F. W. Marquis joined the faculty of Mechanical Engineering as a full professor in 1913. He was given the rank of full professor regardless of the fact that he had no previous teaching experience. Professor Marquis graduated from the University of Illinois in 1905. He worked in design with the C. V. Kerr Turbine Company and then joined the Engineering Experiment Station at the University of Illinois. The excellent record he generated during these eight years after graduation qualified him, in the eyes of Professor Magruder, for the professorial rank. His contributions to the university and to his fellow man during the 33 years he served on the faculty demonstrate that Professor Magruder's confidence was well justified.

During 1913, Aubry I. Brown, a Canadian, also joined the faculty. Professor Brown was a graduate of Acadia University and Ohio State University. His areas of interest were heating and ventilating.

The philosophy of the Mechanical Engineering Department can be divided into a number of periods the first of which includes the time from formation in 1881, until the Second World War. During this period it was felt that engineering graduates should have (1) a solid foundation in the latest scientific fundamentals, (2) the necessary skills to carry out a junior engineering job without further training, (3) knowledge of engineering practice in all mechanical engineering fields, and (4) the ability to do individual engineering design. This meant a very crowded four year curriculum and hence allowed for no broadening courses which are currently so popular. The curriculum was fixed, practically no choice of courses was allowed, and the program was designed so that all courses were relevant. Perhaps we should take notice of this point since we are today (1970) providing broadening courses, courses in which even the liberal arts students have difficulty in finding relevance.

The philosophy of this first period was dominated by the personal philosophy of Professor Robinson. He felt that engineers should be skilled in the art of inventive and innovative design and that they should have as basic tools the fundamentals which would support the design practice. He was a successful engineer himself but his greatest success was as a teacher of his philosophy. This success is demonstrated through the careers of his students, a few of whom are mentioned on page 78 - 84. By inspiring students to creative careers, Professor Robinson made a great contribution to mankind.

THE FIRST WORLD WAR

World War I caught the campus with the same jolt as did the Spanish American War before it. "The war has generally been hindering education due to the general unsettled state of mind. Weaker students tend to enlist, better ones to stay on to learn as much as possible before being drafted." With respect to Government Research, "There has been no attempt to develop the Engineering Experiment Station. This does not signify, however, that no experimental research has been carried on. Practically all of the departments of the college have been pursuing investigations for some branch of the War Department, or some governmental bureau," said the Dean in his report on the College of Engineering for 1918.

Professor Karl W. Stinson, who graduated in 1916 and joined the faculty as an Assistant the same year, notes that the faculty and student body supported the war effort, no demonstrations or opposition to university involvement was noticed.

Professor Magruder devoted much of his time during the war to the School of Military Aeronautics, while Professor Marquis took a leave of absence for the duration of the war to avail the government of his services as a civilian.

After the crisis an accounting was given of what had gone on during the war when everyone was too busy with the problem at hand to bother relating progress.

"The first organization on the campus for war purposes was the School of Military Aeronautics, commonly spoken of as the "Aviation Ground School" for pilots. University faculty staffed this school which was organized in May, 1917, classes beginning in June, 1917, and terminating August, 1918. This school was followed by a school for Adjutants and a School for Balloonists, both of which were staffed by the Army. The numbers of men trained in these schools:

Pilots	1291
Adjutants	887
Balloonist Officers	219
	2397

To finance these programs the State appropriated $80,000. The Trustees from the Endowment Fund gave $11,209.62; the balance of the money used for improvements and changes on the campus came from tuition receipts provided by the Government.

Barracks Construction	$50,310.
Aviation Laboratory	41,325.
Gun Range	764.
Hospital	21,512.
	$92,911

This then means that the State and Trustees essentially funded the buildings for this purpose. Faculty salaries paid at this time diminished, reflecting the fact that the Government was paying the faculty in lieu of the university for their efforts in the Pilots School project.

With the war over and the boys returning, we find the range of courses in Mechanical Engineering for 1918-1919 looking like this:

Steam Power Plants
Heat Power Engineering
Steam Engineering
Mechanism and Machine Design: for Non-mechanical students
Mechanism
Mechanism Drawing
Heating and Ventilating
Materials of Construction
Gas Engines and Producers
Machine Design: Chemical Engineering, Mechanical Engineering
Thermodynamics
Inspection Trip
Reading Course
Hydraulic Machinery
Steam Turbines
Hydraulic Power
Experimental Engineering Laboratory (4 sections)
Machine Design (Industrial Arts Dept.)

World War I initiated what could be considered as the second area and a new philosophy for mechanical engineering education. The war brought a great influx of military students who learned in a few weeks some of the fundamentals of mechanical engineering. Others, who were not so fortunate and received no training on a university campus, learned about mechanical apparatus such as is associated with automobiles, trucks, submarines, aircraft, guns, etc., from short military schools and then through actual experience in using the mechanical apparatus. Many of these military personnel returned to the campus following the war and caused extreme overcrowding of the facilities. This overcrowding continued until the late 1930's; facilities and number of faculty lagged the increased student enrollments throughout this period.

The philosophy of education changed during this second area, not because the faculty desired to change, but because there was no choice but to do the best with the resources which were available. The individual instruction which was previously possible was now impossible. The undergraduate thesis was eliminated first. Next the "mass production" of the laboratory experience was initiated. Broadening courses were introduced and this resulted in a shortening of the engineering course credits; credit in fundamentals was sacrificed. In addition, the total credit was reduced in "state-of-the-art" courses.

During this period students were prepared with depth in the areas of (1) engineering drafting so that the graduate could, without further instruction, make complete working drawings without the intervention of a draftsman and (2) the development of skills for operation of machine tools which carry out many of the manufacturing processes. For example, machine shop tools, foundry practice, and manufacturing processes were emphasized. Later during this period the influence of power courses became more important. Steam power, the internal combustion engine, the automobile and aeronautical engineering were included in the curriculum as this curriculum continued to broaden. Sales engineering, administrative work and the area of human relations engineering were introduced. The philosophy of the department was to provide a thorough but broad foundation in mechanical engineering.

Another practical problem presented itself to the faculty. There was a shortage of textbooks regardless of the fact that used books were common. Engineering practice was changing rapidly; automotive design and aeronautical design represent two areas where textbooks were not available since the areas were so new. The faculty developed classroom notes and passed these on to the students. This was not satisfactory, however, since in some instances one professor would be teaching simultaneously two classes of approximately fourty students each. The success of the program was due in part to the dedication of the faculty and perhaps to a larger part to the dedication, enthusiasm and persistence of the students. Some of the faculty at that time in history noted that these determined students would succeed with or without close faculty guidance, a comment which would again be made about the ex-GI's returning after World War II.

A very strong faculty influence was provided by Carl A. Norman. He joined the faculty in 1917 after considerable design experience, particularly in the area of machine design and gas and steam turbine design. Professor Norman was born in Finland and educated in Germany. He worked in numerous European countries, including Russia, prior to coming to the United States. Design experience and experience in human relations prepared him well for his duties with the Mechanical Engineering Department. He developed his classroom notes from his previous experience and brought them up-to-date with current practice of the time. He used students, as did Professor Robinson, to pursue some of the details of mechanical design. This provided state-of-the-art experience for the student and helped the professor complete a text in machine design which would be used as a standard text throughout much of the world. This text, plus his numerous publications and patents, were very influential in keeping the high national prestige which Professor Robinson had been instrumental in establishing,for the department and its faculty.

Steam Power Engineering, as an area of study, was introduced gradually until around 1918 this general area had replaced the previous major emphasis on steam engines. Professor Marquis taught the first course on steam turbines in 1916. Paul Bucher, a steam power plant engineer with seven years of experience, joined the faculty in 1918. He provided strength and direction in this growing area. He developed strength in the department by establishing and testing boiler codes. His laboratory became the ASME standards laboratory and this laboratory continues today under the able direction of Professor O. E. Buxton, Jr.

E. A. Hitchcock returned to the university in 1920, as the Dean of Engineering. The return of a man, whose enthusiasm and abilities had done so much to inspire students to greatness and to establish the early department policy and curriculum, was certainly good news to the mechanical engineering faculty. His many talents could now be used to help guide the Engineering College.

Suspected no page 45

The 1921 - 1922 Dean's report to the president reveals that the autumn quarter enrollment in mechanical engineering was 347 students and 38 degrees were granted. These numbers represent about 23% of the total engineering enrollment and engineering degrees granted.

In 1921, it was observed that much of the steam equipment used in instructional work was obsolete and was little used in the modern plant. The greatest immediate need of that department's laboratory in 1921 was a modern steam turbine with condensing equipment.

1922 brought with it the requested new steam turbine and the pleasant surprise of an honorary Doctor of Engineering degree for W. T. Magruder from his Alma-Mater, Stevens Institute of Technology. George N. Moffat, a materials specialist, joined the faculty this year as an assistant professor.

There is a reoccuring observation on the part of university administrators which has cropped up every time facilities become over crowded from the days of Professor Robinson to the present. The sentiment runs, "It is quite evident that the institutions in Ohio will more and more serve as feeders to our college. This condition is being encouraged by the faculty for they realize full well the advantages to the student in beginning his university education at a small institution and we also know full well the desirability of having a lighter load upon our already overloaded plant." This is a 1923 quote, with which it is necessary to take some exception in the light of current affairs.

First, the size of the institution is not the relevant factor when a boy or a girl leaves home. What counts is (a) the student/faculty ratio and (b) the willingness of the faculty to develop personal rapport with individual students. On this score, today's Mechanical Engineering Department ranks with the best small schools.

The second point gives rise to near panic at the thought of doing without - and that is the desirability of a counselor from the field of Mechanical Engineering to guide as well as to inspire young people through their first years in college. Neither is it desirable to overlook the value of contact among students within a discipline - the fourth year students can be very helpful to first year students in pointing out good study habits and simply reassuring them that everyone has to work to pass certain courses.

In 1924, the following observation is made by Dean Hitchcock. "Growing institutions can ill-afford constantly changing faculty. Nevertheless it is desirable that young people move from one university where they have received a major portion of their education, particularly their graduate education. A short term of service at their own institution not objectionable, but a free interchange of young instructors would be of benefit for all concerned. When these changes are due to lack of funds - another problem and the situation leaves something to be desired." He refers to the age-old bind common to industry as well as universities of being faced with the choice of hiring new people in at salary levels above the level of existing faculty members or dropping the quality of new people being hired while keeping their salaries below that of older faculty.

In 1924, the university lost another of its pioneers when Professor Mendenhall died.

The rapidly growing Mechanical Engineering Department was soon too large for the space assigned. As a consequence, the previous plans for a separate building "to the west of the present structure" were abandoned and a new automotive wing was constructed according to the request of President Thompson. This addition was completed in 1925. The addition increased the floor space available for use by the department by some 75% and made possible the proper housing of new laboratory equipment and greatly bettered other facilities, especially in machine design. Machine design classes, which had previously been conducted on the balcony, were moved to well lighted rooms. Laboratory apparatus often had been operated directly below and provided distractions.

Dean Hitchcock initiated a college wide series of lectures, in 1923, for the purpose of "broadening out" faculty and students. Some of these lectures were technical and some were of a more general nature. Typical programs were illustrated by the lectures presented in 1928.

"Modern Fire Engines," Professor Karl W. Stinson

"Aeronautics," The Honorable E. P. Warner, Assistant Secretary of the Navy

"Technique of Business Research," Edwin B Neil

"The Importance of Heat Treating," D. H. Eisonmann

"A Talk to Engineers," President G. N. Rightmire

The engineering departments were now quite large and although the broadening lectures were of great use and were successful in the years immediately following initiation they were not too important in 1928, since the departments had initiated their own lecture series. The lecture program was terminated in 1928.

Many graduates remember the year 1927, since this is the year the Boeing Airplane Company donated a Navy monoplane to the department. On Engineer's Day, in 1928, a Waco aeroplane landed on the oval for a rather spectacular and dramatic event.

In 1929, Dean Hitchcock decided to react to the mounting criticism resulting from poor faculty student relations. He created a position called "Junior Dean" with the responsibility of dealing with and making recommendations on personnel problems relating to underclassmen. There were 397 engineering freshmen that year. The Junior Dean spoke with each of these new students, he conducted "fireside" chats, and he conducted a survey course on engineering. Today, a similar program is in effect from the Dean's office and we find it quite effective. The Mechanical Engineering faculty have the responsibility, however, of advising and getting to know personally approximately one dozen undergraduate students. Once a student elects Mechanical Engineering as a major we see to it that he is brought into the family.

During this year Dean Hitchcock was informed that the Mechanical Engineering undergraduate students wanted summer courses so that they could continue their education without interruption. Adequate financial support was not available within the college and this request was denied. The students were told to seek relevant summer work which would provide meaningful experience; however, relevant jobs were difficult to locate. During this difcult time the Bailey Meter Company made a determined effort to provide as many meaningful jobs as possible. The company founder and an Ohio State University, Mechanical Engineering Department Alumnus, Mr. E. G. Baily, demonstrated through these actions the same loyalty to his University as have so many of our graduates shown throughout the years.

There was considerable change in the academic structure in 1929. The Industrial Engineering Department was formed and consequently the total enrollment in Mechanical Engineering dropped as the industrial option was quite popular. The greatest change during the year was the transfer of mathematics, chemistry, and physics to the College of Arts and Science. "It was to be expected that the engineering faculty would not look with favor upon such a change, believing that the most important fundamentals of engineering should be taught in this college. However, since engineers are organization men, regardless of what the decision of their superiors may be, their interest, enthusiasm, and loyalty will not be lessened, and they will always support wholeheartedly all constructive measures."

Another change is reflected in the 1929-1930 Annual Report of the President to the University Trustees. "Professor William Magruder retired from the chairmanship of the Department of Mechanical Engineering after 34 years of service in that capacity. During his chairmanship the department came from a small organization to a very large group of teachers with much enlarged equipment. As the University has grown, a strong effort has been made to carry on the growth of the Department of Mechanical Engineering in a corresponding fashion and Professor Magruder has at all times made a most intelligent presentation of the needs of the department, and when they have been met so far as possible the activities of the department have been correspondingly enlarged. All of this activity has kept reasonable pace with development throughout the University and throughout the educational community. Professor Magruder's services as Chairman of this Department has been a most constructive and progressive one. He is continuing as a professor in mechanical engineering relieved of the large responsibilities of the chairmanship.

"Professor Franklin W. Marquis has succeeded Professor Magruder as Chairman of this Department. He has been a professor in the department for a number of years and brings to the new post both the experience derived from long and successful teaching and the benefits that accrue from practical work from the industries. The Department is in good hands and may be expected to continue in a most progressive way."

The University community has debated its role throughout its history. During 1930 the President's Report states, "A state university must be close to the soil, to the factory, to the trade, to education, to the professions, to the various programs for physical recreation, to the fine arts...

"A state university owes its origin to democratic concepts of the needs of citizenship and fundamental social and industrial service . . ."

The report of the president to the trustees includes discussions on a recently published book titled, Universities and the concluding comment is made - "We are still under the necessity of clarifying our ideas about culture and the practical versus the cultural and although this book advances the discussion it does not answer the questions."

Apparently there was an element of the university community proposing that a university could deal only with high level abstractions and "cultural matters." The praticality of academic work such as is involved in mechanical engineering was far from being considered cultural and as a consequence the practical state institution was being questioned about the right to term itself a university. Today we continue this discussion and in many instances the cultural has prestige while the practical has relevance. Our students in the liberal arts are rebelling against the established cultural programs and are demanding programs which are relevant. Perhaps we shall see a shift in the prestige relationships of our cultural academic programs.

The Engineering College Dean's Report of 1931-32 indicates that the College of Engineering and the Mechanical Engineering Department was progressing very well with regard to enrollment and with regard to maintaining their high academic ranking. The report points out that The Ohio State University ranked 8th in engineering enrollment out of a total of 145 engineering schools in the United States regardless of the fact that the enrollment dropped this year due to 100 fewer freshmen who were unable to meet the new higher entrance requirements as they were imposed. As a consequence these new freshmen had to stay in the Fine Arts. The report points out that during the last two years mechanical engineering enrollment had been in excess of electrical engineering, a condition which had not existed before in over forty years. The Dean points out that this change was undoubtedly due to the popularity of courses in Aeronautical Engineering. In contrast to this report the Mechanical Engineering chairman, Professor Marquis, writes in his annual report to the Dean that interest in enrollment in Aeronautical Engineering had not met expectations and they felt that it was a wise decision not to establish a degree program at that time, but to limit the work in aeronautical to elective senior engineering courses. These courses under Assistant Professor A. J. Fairbanks were expanded in content and provided for advanced aerodynamics, airplane design, aeronautical laboratory work, and a graduate course in advanced aeronautics. The Mechanical Engineering Department report continues that a wind tunnel with the maximum air speed of 104 MPH had been completed, calibrated, and used in instructional research. Professor Marquis' report states that interest and registration in automotive engineering had continued to increase in a satisfactory manner. In addition he comments that a critical study of the mechanical engineering curriculum was in progress and that this study would probably result in certain changes which would tend to keep the department abreast of the times, but that these changes would not be made within the year.

There seemed to be a trend in the growth of the University at this time, with this growth pointing to the divisional unit taking on a more formal function of the whole as the University increased in size. The College went from what was called "Chapel" Meetings, which included the entire College student body, to department level seminars. At the same time the counseling of undergraduates through the Dean's office, which was started in

1930, continued at a much expanded level. The Departments became involved to an expanded level in this counseling as individual faculty members were assigned students as advisees.

The effects of the depression become very apparent in the 1932-1933 reports for the Engineering College to the President of the University. During this year a serious re-entrenchment continued due to the money situation in the state. The decision was made to limit courses to those meeting a minimum enrollment. The Council on Instruction was directed to cancel low registration courses or to offer these courses in alternate years. The results of this re-entrenchment are illustreted as follows.

Courses withdrawn	337
Courses offered alternate years	69
Courses consolidated	33
Courses reduced in frequency	30

The university operations seriously affected by the depression significantly influenced the Engineering College between the years 1930 through 1936. During this period of time there were violent reductions in numbers of personnel as well as wages of personnel who were retained. All members of the faculty and staff receiving $3000 or more per academic year had three drastic cuts in salary while those receiving below $3000 had two cuts in salary. Because of the legislative hangup,(the salaries of all other state employees had been restored completely prior to January 1, 1935) the university staff found its properly expected partial restoration of salaries vetoed by the Governor. In addition, the university's total appropriation for maintenance and operation was reduced by this veto. The Mechanical Engineering Department enrollment decreased 24% in the three years between 1932 and 1935. While this decrease was in progress every effort was made by the faculty to preserve the personal contact with students. Emergency teaching assignments were cheerfully accepted in order to prevent a complete return to the previous condition of mass education which had been quite unsatisfactory.

Professor W. T. Magruder died on June 21, 1935. He had been at Ohio State University for forty years and he not only witnessed but was one of the prime promoters of the great growth of the university from the middle 90's to the middle 30's. He made large contributions through his teaching, through his leadership of the Department of Mechanical Engineering, and through his extensive engineering studies and practice and interest in professional societies. An insight into the feeling concerning Professor Magruder can be seen from the college report at this time which stated, "The staff in the administrative office of the college always accepted with a high degree of satisfaction any report which Professor Magruder would make to it, because, as everyone said, 'It would be correct'."

THE DEPARTMENT IN 1936.

The activities of the department up to the time of the Second World War can be illustrated by use of the annual report of the President to the Board of Trustees in 1936. This report proceeds as follows.

"This department illustrates admirably the truth of an earlier statement made in this report to the effect that no important technological University department can confine to one type the variety of the public services that it renders or can decline the manifold demands for assistance which come to the University constantly and insistently.

"This department, for example, finds it necessary to carry its instructional activities far beyond the boundaries of its classroom to citizens of the state who rely upon the University for assistance. A staff member recently conducted a course on ten consecutive Saturday afternoons for a group of contractors, engineers, and others in a neighboring city. Other members of the staff meet monthly with the Columbus Chapter of the National Association for Power Engineers, bringing to this group the latest information concerning principles and techniques of interest to operating steam engineers. Similar requests from other groups for courses in adult training have had to be denied because of the inability of the department to undertake them, but one member has had charge of a course in the ground school of the Columbus Flying Service and the Curtis Flying Service has conducted an airplane mechanics' school for the American Institute of Practical Mechanics.

"Individual inquiries concerning a wide variety of technical problems come constantly to this department which gives advice and judgments on inventions and devices of various kinds, heating and ventilating equipment problems, physical properties of engineering materials, etc. The department works in close contact with engineering societies. One staff member serves on the Fluid Meters Research Committee of the American Society of Mechanical Engineers; another one is on the Safety Valve sub-committee of the Boiler Code Committee, American Association of Mechanical Engineers; still another is chairman of the Railroad Air Conditioning Committee and a member of the Publication Committee of the American Society of Heating and Ventilating Engineers; and another has served for several years on the Pressure Piping Code Committee of the Industrial Commission of Ohio which recently formulated a safety code for the installation, maintenance and operation of pressure piping and mechanical refrigerating systems and equipment. Two staff members served on a committee which planned the engineering extension to the power plant at the Ohio State Penitentiary. Others have served with the National Association of Fan Manufacturers, have assisted the United States Compensation Board, the State Architect and Engineer, and other federal and state agencies.

"For the Division of Water of the City of Columbus work has been undertaken similar to that done for other Ohio cities involving the development of acceptance tests on pumping units and sub-stations. The department provides a consultant and technical supervisor of research on air conditioning for the Association of American Railroads and this professor conducted during the summer of 1936 a school on air conditioning for the benefit of railroad engineers.

"Research of immediate public service value now under way by the department includes: The investigation of orifice meters in the measurement of water, natural gas, steam and air (partially supported by the American Gas Association); research in automotive engineering, including an investigation concerning the stopping ability of automobiles as related to the gripping of tires upon road surfaces and the measurement of friction; the problem of transmitting power by belting, resulting in publications which have been requested by individuals in all parts of the world; investigation concerning propeller fans and methods of testing them; research on bearings, high strength malleable iron, oxidation tests of lubricating oils, internal combustion engine driven centrifugal pumps, reagents for flue gas analyzing apparatus, etc.

"A public service of prime importance affecting every citizen of Ohio is rendered by the department through one of its staff members who conducts the annual Ohio Fire School. In arranging this course the University receives financial assistance from the Fire Chiefs' Association of Ohio and enjoys the cooperation of the Ohio Inspection Bureau, the American Red Cross and the Fire Prevention Association of Ohio. This year's Sixth Annual Fire School was developed to become an advanced course in fire prevention and fire fighting inasmuch as local communities have been encouraged to establish regional fire schools for more elementary instruction originally given in the campus conferences. This year, for example, the regional fire school at Canton, Ohio attracted 2,447 registrants including approximately 1,500 members of fire departments - probably the largest fire school ever held. Its success was due in large part to the work of the staff member of the Department of Mechanical Engineering. In these schools members of other University departments, notably Chemistry, have given lectures on such subjects as "The Chemistry of Combustion," "Refrigerants and Their Fire Hazards," etc."

The activities of the Mechanical Engineering Department during the 1930's can be summarized by noting that the curriculum remained essentially the same as it had been for the previous decade and by noting the many extra-curricular activities undertaken by the faculty. The student enrollment remained constant with approximately 40 students receiving Mechanical Engineering degrees per year. Although the curriculum remained essentially constant a course relating to petroleum was developed by Professor Roberts and introduced to the curriculum. At the same time a new required course in the field of heat transmission and an elective course in refrigerating and air-conditioning were authorized by the college faculty during the 1937-38 academic year. Requirements for academic work in the field of economics and business law replaced some of the requirements for engineering drawing and shop work. The design courses were primarily oriented toward the design of machine elements. Courses in mathematics did not go beyond integral calculus and most mechanical engineering courses were highly descriptive of the existing art. The curriculum was heavy in shop work and testing-type laboratory courses.

The faculty of the Mechanical Engineering Department participated in many extra-curricular functions. The fact that several pay cuts were retained during the middle 30's did not seem to dampen the faculty's enthusiasm for contributing to the university, to their profession and to their fellow man. Particular examples include the work of Assistant Professor Beitler with the ASME Fluid Flow Research Committee. He was a consultant in the area of metering of fluids and did much to improve our laboratory and our national reputation in this area. Professor Paul Bucher continued work on safety valves as a part of his ASME Boiler Code Committee. His research work resulted in a complete revision of the safety valve section of the ASME Boiler Code. Professor A. I. Brown served as a consultant in the air-conditioning area for the Association of the American Railroads. In that capacity he directed the technical phase of an extensive investigation of passenger car air-conditioning and this included the direction of numerous conferences on this topic. Professors Stinson and Roberts developed and built apparatus for testing automotive engine components and parts. In addition, numerous short courses were presented by Professor Stinson in the area of internal combustion engines. These and other members of the faculty did much to fulfill the service function of the university's responsibility for education, research and service.

History repeated itself with the coming of the Second World War. The Mechanical Engineering faculty once again was faced with an environment and responsibilities similar to those previously faced during the First World War. The number of graduates from the Mechanical Engineering Department with engineering degrees dropped to a low of 11 students in 1945, reflecting the fact that in 1940 and 1941 the enrolling freshmen classes were almost nil. However, a number of programs were developed for educating civilians and military personnel. The ESMWT program for civilians, the Army personnel program (ASTP), and the Navy Diesel Engineering School provided programs through which thousands of students were processed. As of June, 1941, there were 7,403 civilian pilot trainees sent to the Army and Navy. There were 1,262 CP trainees advanced to flight instructors. These numbers indicated that when one includes all the schools that were in progress, the Faculty of the Mechanical Engineering Department actively participated in educating numerous people for the military services during the Second World War.

On March 8, 1943, the University Trustees approved the creation of the Department of Aeronautical Engineering. Once again the Department of Mechanical Engineering had developed an area of study which evolved into a formal department.

THE FIVE YEAR PROGRAM INTRODUCED - 1945

The end of the war brought with it not only a large influx of ex-GI's as students, but also a major change in the Mechanical Engineering curriculum. In 1945, the five-year BME program and the combined BME-MSc program were approved. The changes in the undergraduate curriculum were very significant with the most important changes as (1) the addition of an advanced mathematics course, including differential equations and some vector analysis; (2) the addition of 36 hours of Basic Education Requirement courses to meet the Engineering Council for Professional Development requirement for courses in the humanities and social sciences; and (3) the character of the courses was moved largely in the direction of engineering science; however, the additional year made it possible to have a program which was heavily design-oriented.

Professor Aubrey I. Brown was Acting Chairman of the Department in 1942, and became the Chairman of the Mechanical Engineering Department in 1946. He was the professor of heating and ventilating, and authored several texts on heat transfer.

The last half of the 1940's brought many changes to the department. These changes can be noted by referring to Table 1 and noting that 199 Bachelor's degrees were given in 1948. This was the result of the peak of the ex-GI enrollments. Prior to this time the department had awarded only one PhD degree. By the late 1940's the graduate student enrollment had reached approximately 30 Master level students and 10 PhD students.

Table 1. Statistics of degrees granted in the Mechanical Engineering Department. The department was officially established in 1882, as Physics and Mechanical Engineering was split into two departments. In 1965, the Nuclear Engineering (N.E.) degree was approved and the first degrees were given in 1966.

Year	Bachelor's	Master's	Ph.D.	Professional
1880	1			
1881	--			
1882	--			
1883	2			
1884	1			
1885	3			
1886	1			
1887	2			
1888	4			
1889	2			
1890	3			
1891	--			
1892	--			
1893	2			
1894	1			
1895	2			
1896	4			
1897	9			
1898	6			
1899	6			
1900	9			
1901	6			
1902	11			
1903	17			
1904	15			
1905	19			
1906	15			
1907	15			
1908	14			
1909	16			
1910	20			
1911	23			
1912	18			
1913	18			
1914	21			
*1915	28			
1916	26			
1917	21			
1918	10			
1919	6			
1920	22			

*Here change was made from M.E. to B.M.E. degree.

Year	Bachelor's	Master's	Ph.D.	Professional
1921	43			
1922	38	1		
1923	54			
1924	49	1		
1925	34			
1926	39			
1927	24			
1928	29	2		4
1929	25			
1930	32			2
1931	24	1		1
1932	28	4		6
1933	39	5		2
1934	41	3		4
1935	51	5		
1936	39	2		3
1937	38	1		3
1938	41	3		1
1939	44	2		3
1940	58	1		2
1941	58		1	
1942	40			1
1943	80			
1944	18			1
1945	11			
1946	17	2		
1947	93	6		1
1948	199	7		3
1949	103	18		1
1950	131	26	2	
1951	145	37	1	
1952	60	10	2	
1953	48	15	1	
1954	42	12	3	
1955	39	8	2	
1956	51	14	1	
1957	61	8	1	
1958	73	12	1	
1959	81	14	2	
1960	66	18	5	
1961	52	14	1	
1962	50	15	6	
1963	48	11	6	
1964	48	8	4	
1965	54	17	5	

Year	BME	BSME	Total	ME	NE	Total	ME	NE	Total	
1966	63		63	12	2	14	4	0	4	
1967	61		61	10	6	16	5	0	5	
1968	67		67	25	6	31	8	0	8	
1969*	30	42	72	23	9	32	6	3	9	

* Estimated

Professor Salvatore Michael Marco was named Chairman of the Department of Mechanical Engineering in 1952, after Professor Brown had resigned. Mike Marco, as his colleagues affectionately call him, graduated from East Tech High School in Cleveland, Ohio, prior to enrolling at The Ohio State University. In college he pursued the Bachelor's and Master's degree in Mechanical Engineering. He graduated with his Master's degree in 1932. After receiving this degree he taught for one year as an assistant instructor in the department. He then worked for the Dayton Rubber Manufacturing Company as a mechanical engineer for two years. In 1935, he returned to the campus and and a teaching career which, today, holds the same challenge and inspiration that it has had for 30 some years for Professor Marco.

Professor Marco was an enthusiastic supporter of the five-year program and of the expanded graduate program. This enthusiasm coupled with his great talent for leadership carried the Mechanical Engineering Department through the 1950's with many innovations in curriculum and faculty activities.

During the 1950's significant changes were made in the laboratory design courses. The laboratory courses were converted from "testing courses" into three types of laboratory courses. These were: (1) a measurements laboratory where students were taught the fundamentals of mechanical engineering instruments and measurements, with the emphasis on measurements of transients; (2) course-oriented laboratories in which students performed experiments designed to illustrate principles being studied in the various engineering science and design type courses; (3) experimental analysis laboratory courses where students solved engineering problems by the experimental method which included separate projects for each small group of students. To assure effectiveness these laboratory sections were kept small with frequently no more than 8 or 10 students for each laboratory section.

In the late 1950's the department began the development of a program in preliminary design which was oriented toward a more scientific approach to the design process and to the use of projects to provide students with experience in the design of mechanical engineering systems. The five-year program provided time so that the students could carefully follow a design through the conceptual stage to the stage where they could see the success or failure of what they had created. In the last half of the 1950's the Engineering College converted the five-year Bachelor's program into a two-year pre-professional program plus a three-year professional program. This facilitated the enrollment of all students in a relatively common two-year curriculum; hence students were not enrolled in the mechanical engineering professional program until the beginning of their third year.

The program was arranged so that incoming students would enroll in a pre-engineering curriculum and, succeeding in their first two years, they would move on to the professional program which included the final three years of academic work.

The pre-engineering curriculum presented a foundation in Mathematics, Chemistry, Physics, Engineering Drawing, and English, probably differing only slightly in general content from its counterpart in many other universities. All engineering students entered this pre-engineering curriculum. Aside from the similarity with other universities the divided five-year program assumed a position unique among engineering colleges. The third year, which was the first professional year, offered basic engineering sciences including modern physics, strength of materials, dynamics, thermodynamics, kinematics and properties of engineering materials.

The second professional year applied these basic laws and concepts to general studies of engineering components and systems. These courses included principles of mechanical design, chemical and nuclear heat generation, heat transfer, heat exchangers, turbomachinery, positive displacement machinery and environmental control plus an introduction to electrical engineering to enhance the basically mechanical foundation.

Finally, the third professional year was directed toward design courses utilizing previous material and offering laboratory experience with actual projects and problems. Technical elective courses were also offered during this year allowing a student to specialize in areas of particular interest to the student. Details of the curricula can be seen by referring to Table 2.

It was during this period that undergraduate and graduate courses in controls and control systems were initiated. In addition a course in the design of heat exchangers was added to the curriculum. Modern physics was an added requirement to the undergraduate program.

In the period between 1961 and 1963, a complete remodelling of Robinson Laboratory was effected. This provided approximately 100,000 square feet of modern air-conditioned facilities for classrooms, offices, laboratories and service facilities. In 1963-64, funds for the purchase of new laboratory equipment were made available. The cost of the building alteration was approximately $800,000 and the equipment expenditures approximately $175,000.

During this period the Mechanical Engineering Department developed new graduate courses in the areas of fluid flow, heat transfer, kinematics and thermodynamics. Undergraduate courses in the area of energy conversion were coördinated and new material was introduced. The introduction of these new courses was the result of the continued expansion of the graduate and undergraduate programs. These expansions were designed to meet the ever-broadening areas of activity of mechanical engineers throughout industry and throughout the government.

In the Autumn of 1964, Dr. Donald D. Glower was invited to join the faculty of the Mechanical Engineering Department with the responsibility for developing a curriculum and student body for a Nuclear Engineering Program. Prior to coming to The Ohio State University to establish the program in Nuclear Engineering, Professor Glower's experience had included teaching at Iowa State University where he had received both his Master's in Mechanical Engineering and his PhD in Nuclear Engineering; basic research with the Bell Laboratories System; and administration with the AC Electronics Division of General Motors Corporation.

The Trustees of the University approved the request of the Department of Mechanical Engineering for offering the MSc and the PhD degrees in Nuclear Engineering beginning with the Summer Quarter 1965. Equipment grants of approximately $85,000 from the U.S. Atomic Energy Commission and approximately $20,000 from the State of Ohio facilitated the development of experimental laboratories as they were necessary for this new program.

Table 2. A comparison of early and current mechanical engineering curricula at The Ohio State University. The change to the five year program in 1945 and the return to a four year program is reflected by the total credit requirements.

COURSES	QUARTER CREDIT HOURS			
	1899-1900	1949-1950	1968	1969
BASIC				
Chemistry	10	12	12	8
Computer			3	3
Drawing	19	15	6	4
English	$13\frac{1}{2}$	9	9	9
Mathematics	31	35	25	25
Physics	14	15	20	15
Shopwork	22	12	4	4
MECHANICAL ENGINEERING				
Automatic Controls			4	4
Boilers and Prime Movers (including internal combustion engines)	10	6	0	0
Combustion and Fuels	3	4	3	3
Fluid Mechanics			5	8
Heat Transfer	0	3	7	4
Heating and Air Conditioning	0	4	3	0
Human Aspects of Engineering	0	4	1	1
Fluid Machinery	2	3	6	6
Kinematics and Dynamics of Machines	7	5	9	5
Machine Design	15	15	12	12
Materials or Metallurgy	4	5	0*	0*
Mechanical Engineering Laboratory	13	11	9	6
Systems Analysis			0	8
Systems Design			9	3
Technical Electives (not necessarily in Mechanical Engineering Department)	0	14	12	12
Thermodynamics	5	10	10	8
Thesis	5	0	0	0
NONMECHANICAL TECHNICAL				
Bridge Strains	5	0	0	0
Electrical Engineering	8	12	12	7
Engineering Survey and Senior Assembly	0	3	2	1
Industrial Engineering	0	3	4	0
Mechanics and Strength of Materials	15	16	16	12
Metallurgical Engineering			4	3

*Now listed under nonmechanical technical.

COURSES	QUARTER CREDIT HOURS			
	1899-1900	1949-1950	1968	1969
NONMECHANICAL TECHNICAL Cont.				
Photography	2	0	0	0
Shop Appliances	3	0	0	0
Structural Engineering	0	3	0	0
Timber and Masonry	3	0	0	0
NONTECHNICAL				
Economics	0	6	5	5
Economic Geography	0	3	0	0
History			5	5
International Studies	0	9	0	0
Modern Language	12	0	0	0
Nontechnical Electives	0	15	25	20
Physical Education and Hygiene	0	4	4	4
Philosophy	0	3	0	0
Political Science	0	3	0	0
Psychology	0	3	0	0
Total, exclusive of Military Science Inspection Trip and Summer Industrial Experience	221½	265	246	205

THE RETURN TO A FOUR YEAR PROGRAM

The faculty of the College of Engineering met during the academic year 1968-69 and approved the return to a four-year program. This decision to drop the five-year program was reached after considerable debate. Faculty committees had been investigating the advisability of this move for several years. What had been thought to be a leadership role, namely, the initiating of a five-year program, had been shown by time to be a rather lonesome role. Only a few of the nation's leading colleges went to the five-year plan. The years preceding 1968 had seen the last two major universities, Cornell and Minnesota, leave the five-year program and, as a consequence, The Ohio State University College of Engineering remained as the last of the major universities with a five-year undergraduate curricula.

There were many arguments, both pro and con, concerning the five-year program. Many faculty and many of our alumni felt very strongly and expressed these feelings. It is difficult to say whether those who were for the five-year program or those who were opposed to it expressed their feelings more convincingly. Arguments were made concerning a loss of enrollment due to the fact that the State of Ohio had instituted mechanical engineering programs at many other state colleges. Professor Marco made many studies of enrollment trends not only at Ohio State and other Ohio universities but at universities throughout the United States and he pointed out that every study he made indicated that The Ohio State University held its own enrollmentwise. Furthermore he pointed out that the students we had during this five-year program were among the best students he had seen. He felt that these students, by picking a five-year school, seemed to demonstrate their intense motivation to learn.

On the other hand there were arguments that industry did not reward the students from The Ohio State University for their extra year of academic work. That is, students who had received a Bachelor's degree in four years and who went into industry were often receiving larger financial remuneration at the end of five years than were The Ohio State University five-year graduates. In addition, there were students who would receive a Bachelor's degree at other four-year institutions and who would then come to The Ohio State University and receive a Masters degree at the end of their fifth academic year. This discrepancy was reduced just prior to the termination of the fifth year program by lowering the academic requirements for admission to the combined program. The combined program allowed a student, during his fifth year, to elect advanced courses so that he could receive both the Bachelor's and Master's degree at the time of graduation. The requirement that a student have a 3.0 grade point or better prior to admission to the combined program was lowered to 2.7 to be compatible with the Graduate School requirements for the rest of the University. Regardless, however, the students felt that the combined program was a rather severe program in that they were required to take high level courses and heavy loads. In many instances, rightly or wrongly, the student felt this may affect his academic cumulative grade point and he was reluctant to enter the combined program.

A very strong point of the five-year program had been the depth that could be achieved in the area of design. The return to the four-year program required that much of the depth in design would have to be left out of the program. The response of graduates and friends in industry overwhelmingly pointed to the strength in the design area. The department faculty decided that it would be wise to retain as much of this strength as possible and voted to incorporate a new program which would have this depth in design. This program evolved into a fifth year after which the student would receive a professional degree titled "Mechanical Engineer."

It is particularly interesting to note the changes that have evolved in the academic programs since the late 1800's to the current four-year program leading to the Bachelor's degree. Table 2 tabulates these programs according to course title and academic credits. The table does not reveal, however, that the level at which many of the courses are taught has been greatly increased. For example, in the area of design, the basic graphical layout of a cam was initially done by the engineer sitting at the drawing board. In 1970, we find that the cam can be drawn by computer and the configuration can be very readily altered as is desired by the engineer. We find that complex systems are readily analyzed by use of the computer whereas, previously, such analyses were impossible.

When one looks at Table 2 it would appear that many of the same topics are covered today as were covered in the 1800's when the curriculum in Mechanical Engineering was first initiated. This is hardly the case, however, and in fact many people have said that the engineering subject matter includes very little in 1969-70 that was in the curriculum as recently as 1935. New materials and new energy sources coupled with the analyses and design possible for very complex systems have greatly changed the engineers' outlook. A mechanical engineer in 1970 is willing to tackle problems which would previously have required many engineers' lifetimes for the analysis.

Professor Marco resigned from the chairmanship of Mechaical Engineering effective June 30, 1968. His leadership and professional work had further enhanced the national reputation of the department. After 16 years as department chairman (and several recent years with failing health) he decided that he would prefer to be relieved of the duties of the chairmanship so that he could spend full time working with students. His particular interest was in building of research and teaching in the area of industrial noise reduction.

Professor Donald D. Glower was named chairman of the department effective July 1, 1968. He had previously been directing the Nuclear Engineering Section of the Department of Mechanical Engineering and teaching courses in nuclear energy conversion.

Considerable detail was given to the engineering curriculum at the time when the university was organized. It seems quite appropriate therefore that a rather detailed description should be given of the Mechanical Engineering Department activities during the 1969-70 academic year.

DEPARTMENT PHILOSOPHY AND ORGANIZATION (1969-1970)

The mechanical engineering faculty and students of the University's Centennial Year live at a time in history which is not too different from that experienced by previous generations. The Viet Nam War is perhaps as unpopular a war as the United States has ever fought and this is reflected in the student and faculty attitudes. The financial support from the State compares in the same relative manner with Michigan and other neighboring big ten schools as it has throughout our history, i.e., only a fraction of the support they receive. Our faculty as in past years makes up this support differential by providing funds through grants and contracts with industry and government. Our graduates were probably never more sought after than they are today. Many jobs exist and are offered for each of our graduates. However, because alternatives to military service are not offered as yet, significant numbers join the military forces upon graduation. Our students and our faculty are busily engaged in activities which are relevant to the times and which will predictably result in devices and systems which will build a better tomorrow.

The great engineer Theodore von Karman once said, "Scientists study the world as it is; engineers create the world that never has been." History has provided us with the evidence which demonstrates that the faculty and students who have been associated with the mechanical engineering program at The Ohio State University have done much to create new worlds for future generations. The faculty and students who are at the University during the Centennial Year are of the same high quality as were their predecessors and they can be counted upon to help create a new world for the coming generations during the next 100 years. The same dedication to education, research and service for the betterment of man remains the policy of the department as it was the established policy of the University at its founding. The faculty has dedicated their efforts to providing the highest quality education, research and service. The very high regard which our faculty and program has in the eyes of our peers demonstrates that we have been very successful in working toward our goal.

Inspirational education in depth remains as the major responsibility of the faculty. The years have provided experience which demonstrates that enthusiastic teachers, using the proven techniques, lectures, recitation, laboratories, seminars and individual tutoring through discussions on course work and research and development investigations, can groom a young man to reach his maximum potential in the shortest possible time. The education program is designed to meet, as well as possible, the needs of today's industry and the career requirements of the student over the next twenty to thirty years. At this time, perhaps twenty to thirty years after graduation, the student will have reached, on the average, his maximum productive capability.

The faculty pursues state-of-the-art research to help maintain our high national stature with regard to quality education. It is this reputation for high quality which aids our graduates in obtaining meaningful jobs after graduation. The faculty's enthusiasm for new discoveries and inventive design carries over to the students and demonstrates relevance in education and practice and provides a means of indoctrination into the latest innovations of the art of design. This approach to discovery and creating new things for a new world is as important today as it was when Charles F. Kettering, ME-EE '04, pointed out "we should all be concerned about the future because we will all have to spend the rest of our lives there." Research experiences help to prepare the student so that he will be a member of our society who cannot only recognize and identify a problem but actually carry through and remedy the situation. This is what relevance is all about.

Research as performed by our mechanical engineering faculty has a somewhat different meaning than is usually inferred by the scientist. The scientist is educated in the technique of investigating nature and formulating laws and principles to describe nature. Pure science is not interested particularly in applications and indeed many of our great physicist-scientists have often said in effect that if it is practical it is not interesting. Our engineering research is more applied and in fact usually means "research and development" since it is applied to the solution of a practical problem. True, the mechanical engineer must often investigate and formulate a law or principle of nature since our problem often lies in an area which is of little interest to the scientist. When this is the situation, basic research is performed, a law is formulated, mathematical models are constructed and then the art of design is applied. The Ohio State University mechanical engineering program is particularly strong with emphasis on innovative design. Our philosophy is to inspire the students in this important engineerng art so that our graduates are particularly expert in solving current problems and inventing for the future. That art of innovative design and the background fundamentals and techniques to support it represent the focal point of our mechanical engineering program.

Although the department philosophy regarding service has changed little over the 90 years of the department history, it must be emphasized that our faculty today is more than ever before involved in civic and cultural functions. The same enthusiasm and dedication of yore is demonstrated through involvement by helping our state and city agencies, our neighboring industries, and our neighboring universities solve engineering problems. The department continues to have the standard laboratory for safety valves and boiler codes as well as for metering the flow of fluids. A new sense of responsibility to the community by our faculty has resulted in many of our professors becoming involved with local schools, becoming scientific-engineering advisors for civic communities dealing with things like air pollution, becoming participating members of civic groups such as the civic symphony, art museum, and the Center of Science and Industry. In addition to the many service functions, the faculty serves the community by being leaders in research which provides new devices and innovations to help better the quality of living.

The Mechanical Engineering Department consists of the students, the faculty, the staff and the facilities. There are approximately 300 undergraduate students, 180 graduate students, 10 supporting staff, 28 faculty, and 8 graduate teaching assistants. The research budget from the Federal Government and industry is approximately $300,000 per year. The department's tangible productivity is the approximately 70 BSME graduates each year, the approximately 30 MSc graduates each year, the approximately 10 PhD graduates each year, the numerous technical publications and seminars of the faculty, and the numerous service functions of both a professional and civic nature.

Appendix B, pages 91-92, shows the faculty organization chart where each section represents a basic interest group. Each faculty member has an interest in and works on research in areas which overlap the other three sections; however, the grouping of faculty facilitates course and curriculum development and helps provide colleagues of common interest for a team effort with specific topics in research and development projects.

FACULTY ACTIVITIES

The faculty of the Mechanical Engineering Department fulfill their responsibilities in the area of education, research, and service by lecturing and guiding students through their academic programs, by pursuing research investigations to serve their students, their community and themselves, and by serving on committees and other controlling bodies throughout the community and the university. On the average the faculty members work a 60 hour week; 40 hours at the university working with students and university duties and 20 hours of study and lecture preparation. The academic load for lecture and recitation is about 10 contact hours. Counseling undergraduates and guiding and counseling graduate students who are working on theses and/or dissertations requires about 16 hours per week. Paper grading requires about 6 hours per week and lecture preparation takes about 20 hours per week. Committee activities and other university functions require 2 to 3 hours per week. In addition to the local activities, many of the faculty are active nationally with respect to professionally oriented committees and spend between 4 and 8 hours per week on consulting activities with government and industry.

Inspirational and quality teaching are the minimum qualifications of each faculty member. Although undergraduate courses are not taught by the same professor for more than three consecutive years all professors do have contact with undergraduate students. Some graduate courses represent the specialty of a specific faculty member and this particular professor has the responsibility to present the course including appropriate state-of-the-art information. The faculty is evaluated each year by the students and the written summary of their views are presented to the faculty member and the department chairman. Ineffective teaching is soon corrected.

All faculty members have students for whom they provide counselling. Each faculty member has on the average 10 to 14 undergraduate advisees. Each year the undergraduate students receive a new faculty advisor. The advisors see to it that they get to know their advisees during the year; this means that each undergraduate knows at least three professors well enough to use them for reference, etc., after graduation. Frequently, faculty members entertain their advisees as a group in their homes. This has the added benefit of helping the students get to know each other.

In addition to the undergraduates each professor has graduate students to counsel. Although the average is 7 graduate students per faculty member, some of the senior faculty work with as many as 12 to 14 students, while some of the junior faculty may be working with only a few graduate students. Such loads are not constant and when a faculty member has a large number of graduate students it usually reflects the fact that a number of them are new students and have not started research. It may also reflect the magnitude of the contract research of the particular faculty member.

The departments are expected to provide support for graduate students and for themselves through contract research. The state allocation of funds is only a small percentage of that needed to support the graduate program. In addition, most graduate students are married and need financial support which averages about $267 to $300 per month for a beginning MSc student to $300 to $400 per month for a PhD candidate working on research 20 hours per week. The faculty provide this needed financial support by obtaining contracts and grants from the government and industry. The time the faculty member spends on research is charged to the particular contract. This in effect means that the faculty member's salary while working with a graduate student on research is not paid for by the State. A relative understanding can be gained by considering the fact that about 75% of all engineering (in the U.S.) contract research is supported by the Federal Government and on the average about 30% of the engineering faculty wages comes from the Federal Government. Industrial people sometimes wonder aloud about our research and why we are so obviously oriented toward the Federal Government programs. It seems industry must provide more financial support otherwise the college faces the problem of indirect control of higher education by the Federal Government.

Faculty members were selected and invited to join the Department since their abilities, experience, and interests met with the philosophy of the university with regard to the Department's mission. A brief insight can be gained by considering the following brief description of the current faculty.

Professor DONALD D. GLOWER (BS, Marine Eng., U.S. Merchant Marine Academy, 1946; BS, Science, Antioch College, 1953; MSc, Mech. Eng., Iowa State U., 1957; PhD, Nuc. Eng., Iowa State U., 1960) was named Chairman of the Department of Mechanical Engineering in 1968. Prior to joining the Mechanical Engineering faculty in 1964, he had approximately 4 years industrial experience as a Marine Engineering Officer, approximately 6 years teaching experience at Iowa State University and approximately 4 years industrial experience at the Sandia Laboratory and at the General Motors AC Electronics Division. Professor Glower is the author of several textbooks, has numerous technical journal articles, and several patents. He has established an international professional reputation in the area of nuclear energy and has consulted with numerous industrial organizations and universities, with research contracts which have at times approximated $100,000 per year of research effort providing support for equipment and numerous graduate students.

Professor HENRY R. VELKOFF (BSME, Purdue U., 1942; MSc, Mech. Eng., OSU, 1952; PhD, ibid., 1962) is chairman of the Thermo and Fluid Engineering Section of the Department of Mechanical Engineering. He is an internationally renowned expert in the area of helicopter design and analysis, and in the area of electrostatic fields and fluid flows. He has 16 years experience with the Air Force at Wright Field and was a branch chief prior to joining the faculty at The Ohio State University. Prior to joining the Wright Field organization Prof. Velkoff had approximately 5 years experience with various aircraft companies. He is a prolific contributor to the technical literature and a sought after consultant as well as a dynamic and inspiring teacher. His research contracts have been approximately $100,000 per year. These projects support many students, purchase considerable experimental equipment for the department and furnish a significant percentage of his faculty salary.

Professor KENNETH G. HORNUNG (BME and MSc, Mech. Eng., OSU, 1952; PhD, ibid., 1959) is chairman of the Mechanical Design Section of the Department. He has been on the faculty for 13 years, with six years of full-time industrial experience prior to joining the faculty. His wide consulting and frequent publications reflect his professional reputation on a national level. His current research is in the area of bearing characteristics and design and in analyses of V-belt performance and applications. Professor Hornung has worked with his colleagues from industry on research contracts in various areas of mechanical design and through these contracts has provided support for numerous students and faculty as well as experimental apparatus for the department.

Professor CHARLES DINGEE JONES (BSME, Lehigh U., 1947; MSc, Mech. Eng., U. of Kentucky, 1948; PhD, Mech. Eng., OSU,1952) is chairman of the Systems Design and Automatic Controls Section of the Department and has been with the faculty for 13 years. He has specialized in the area of heat transfer and energy conversion, with particular emphasis on fluid power devices and their operating characteristics. Professor Jones has had extensive consulting experience with industry. His areas of research and publications include the design and analysis of heat transfer enhancement techniques with particular emphasis on cooling of electronic equipment. He is considered an excellent teacher and is sought after as an advisor for graduate research.

Professor SALVATORE M. MARCO (BME, OSU, 1930; MSc, ibid., 1932) served as the Department Chairman for 16 years and has taught on the faculty of the Department of Mechanical Engineering for 34 years. Professor Marco ranks among the distinguished OSU graduates. He is the author of a renowned textbook, published numerous technical journal articles, has had extensive consulting work, and has an accomplished research record in almost all aspects of mechanical design as well as thermal and fluid engineering. Since leaving the chairmanship he has been active in establishing a laboratory and a research program concerned with industrial acoustics, the newly established federal regulations on noise maximum having given a particular importance to this program.

Professor CHARLES F. SEPSY (BME, U. of Tenn., 1949; MSc, Mech. Eng., U. of Rochester, 1951) has been with this department for 13 years. During his time with our faculty he has established a national reputation in the heating and ventilating area. He continues to supervise research contracts which exceed $100,000 per year and support faculty and a sizeable number of graduate and undergraduate students. He also has the responsibility for carrying on the fluid metering program which was begun in the early 1900's. He is professionally active in ASHRAE and publishes regularly in the ASHRAE Journals.

Professor WALTER L. STARKEY (BSME, U. of Louisville, 1943; MSc, Mech. Eng., OSU, 1947; PhD, ibid., 1950) has been with the faculty of The Ohio State University for 22 years. He has extensive industrial experience through his consulting work in the area of mechanical design. His national reputation was established through publication of numerous technical investigations and a number of patents. Research currently in progress includes fretting fatigue studies and other fatigue failure problems. These research investigations have throughout the years been supported through contracts which at times have exceeded $100,000 worth of research effort per year and provided valuable support for students and equipment for the Mechanical Engineering Department.

Professor LIT S. HAN (BSME, Chia-Tung U., Shanghai, China, 1945; MSc, Mech. Eng., OSU, 1948; PhD, ibid., 1954) is a dynamic teacher who has been on the Mechanical Engineering faculty since 1954. He has established himself as an expert in the area of theoretical analysis in fluid dynamics and heat transfer. From 1962 to 1964 he was at the Max-Planck Institute, Göttingen, Germany and Braunschweig Technical University at Braunschweig, Germany. He is a frequent consultant with industry and a steady contributor to the technical literature. His research projects have provided support for numerous graduate students.

Professor ERNEST O. DOEBELIN (BSc, General Eng., Case Inst. of Tech., 1952; MSc, Mech. Eng., OSU, 1954; PhD, ibid., 1958) has spent the last 15 years of his professional career on this faculty. The inspiration of his teaching is illustrated by pointing to his selection by the University for the plaque for Distinguished Teaching and an award of $1,000, in 1964. This University award demonstrates the very high regard his students and colleagues on the faculty have for him. He has received international recognition through his textbooks which have been used throughout the world. His area of expertise is in mechanical instrumentation and automatic control systems.

Professor Emeritus SAMUEL R. BEITLER (BME, OSU, 1921) spent 41 years as an active faculty member at The Ohio State University prior to retiring. He joined the faculty in 1921 and developed an international professional reputation in the area of hydraulics and fluid metering devices. He accepted a position as an administrative assistant to the University President, Howard L. Bevis, in 1954, and remained in this position until 1959. He returned to teaching for three years and then retired as an emeritus professor. He has continued his professional career and is currently director of research of the ASME, commuting between his office on campus and his New York City office. He is the Executive Secretary for the International Conference on Steam, Chairman of the Advisory Panel for NBS, and Chairman of the United States Committee for the International Standards on Flow Measures.

Professor HAROLD A. BOLZ (BSME, Case Inst. of Tech., 1933; MSc, ibid., 1935) came to The Ohio State University from Purdue University. He joined the faculty in 1954 as Associate Dean of the College of Engineering and Professor of Mechanical Engineering. He was named Dean of the College of Engineering in 1958 and retained the professorship in Mechanical Engineering. Dean Bolz is the author of numerous technical articles in mechanical design and personnel subjects. He is the editor of the Mechanical Handling Handbook.

Professor CHARLES W. McLARNAN (BS, Mathematics & Physics, Ohio Weslyan U., 1951; BME, OSU, 1954; MSc, ibid., 1955; PhD, ibid., 1960) has served with this faculty for 15 years. His speciality is in the area of mechanisms and he enjoys an international reputation. He joined the staff of the University President, Novice Fawcett, in the autumn of 1969, and his duties are involved in helping to unravel the problems associated with the local university campus of 40,000 students.

Professor MARION L. SMITH (BSME, Louisiana State U., 1944; MSc, Mech. Eng., OSU, 1948) joined the mechanical engineering faculty in 1947. He specialized in the area of fuels and combustion. He regularly contributed to the technical literature of his field and was an inspiring teacher. He assumed the position as Associate Dean of the College of Engineering in 1958, and has been on leave from teaching duties since that date.

Professor Emeritus KARL W. STINSON (BME,OSU, 1916;ME, ibid., 1924) joined the faculty of Mechanical Engineering in 1916 and remained with the department for about a year and then joined industry. He returned to the faculty in 1921 and has lead a very distinguished career since that date. His career has resulted in an international reputation in the area of automotive engineering and internal combustion engines. His books and technical publications have contributed to his profession. He continues to pursue research in the area of internal combustion engines with the object being reduced pollutants in the exhaust gases.

Professor RICHARD H. ZIMMERMAN (BSME, Fenn Col., 1943; MSc, Mech. Eng., OSU, 1946) joined the faculty of Mechanical Engineering at The Ohio State University in 1946 and rapidly established himself as an inspiring lecturer and teacher. He received the University's Distinguished Teaching Award in 1960 of $1000 with a plaque designating him a distinguished teacher and professor. He has published textbooks, technical articles, and has participated in many professional society functions. His area of specialization was thermodynamics, heat transfer and fluid mechanics. He assumed duties as Dean of University College in 1965, and was given a leave of absence from the Department at that time.

Associate Professor OWEN E. BUXTON, JR. (BSME, Purdue U., 1945; MSc, Mech. Eng., OSU, 1951) has been with the faculty of the Mechanical Engineering Department for 17 years. He has approximately 5 years industrial experience with stationery power companies and with various oil companies. His area of specialization is thermodynamics and heat transfer with emphasis on power cycles. Associate Professor Buxton is responsible for the standardization laboratory which tests and certifies safety relief valves. He has been active in professional societies and is a frequent contributor to the technical journals.

Associate Professor HELMUTH W. ENGELMAN (BME, OSU, 1940; MSc, Mech. Eng., Case Inst. of Tech., 1942; PhD, U. of Wisconsin, 1953) has been with The Ohio State University for 4 years. Dr. Engelman had approximately 10 years industrial experience with the General Electric Company prior to joining the Mechanical Engineering faculty. His area of specialization has been automotive engineering and internal combustion engines. He has been a regular contributor to the technical journals and is pursuing research to improve the performance characteristics of internal combustion engines and in the area of automotive accident analyses.

Associate Professor JOHN E. LYNCH (BS, Civil Eng., Michigan State U., 1953; MSc, Nuc. Eng., U. of Michigan, 1960; PhD, ibid., 1968) is a member of the Nuclear Engineering Section and is specializing in the area of nucler radiation interactions and the computer analyses of these interactions processes. Professor Lynch joined the Mechanical Engineering faculty in 1967.

Associate Professor MICHAEL J. MORAN (BSME, U. of Wisconsin, 1961; MSc, ibid., 1963; PhD, ibid., 1967) joined the faculty of The Ohio State University in the autumn of 1967. Dr. Moran has already distinguished himself as an inspiring teacher and a prolific contributor to the technical journals. His area of research and professional interest is thermal and fluids engineering with particular interest on the mathematical approach to thermodynamics problems.

Adjunct Associate Professor DONALD C. BRUNTON (BS, Eng. Physics, Queens U., Kingston, Canada, 1940; PhD, Physics, McGill U., Montreal, Quebec, Canada, 1948) has responsibilities with the Mechanical Engineering Department in the area of Nuclear Engineering with specific teaching and research counseling assignments in the area of nuclear and industrial instrumentation. Dr. Brunton is the President of BRUN SENSORS Incorporated and has approximately 20 years industrial experience. He provides insight and counsel with regard to the academic needs for a manufacturing industrial organization.

Adjunct Associate Professor HAROLD M. EPSTEIN (BS, Physics U. of Colorado, 1950; PhD, Physics, OSU, 1962) joined the Department in the Nuclear Engineering Section with responsibilities in the fusion area. Dr. Epstein has approximately 16 years industrial experience with the Battelle Memorial Institute and has extensive publications in the plasma-fusion area. Dr. Epstein is assisting the teaching and research program in the fusion area.

Adjunct Associate Professor ROBERT F. REDMOND (BS, Chem. Eng., Purdue U., 1950; MSc, Mathematics, U. of Tenn., 1955: PhD, Physics, OSU, 1961) has been associated with the Mechanical Engineering Department since 1966 through the Nuclear Engineering Program. He has responsibility for teaching courses in the area of neutron transport theory, nuclear reactor safety analysis and has responsibility for guiding PhD candidates with their dissertations. Dr. Redmond brings to us approximately 17 years experience at the Oak Ridge National Laboratory and the Battelle Memorial Institute. He provides an excellent insight into the industrial research environment.

Assistant Professor E. WILLIAM BEANS (BME, OSU, 1953; MSc, ibid., 1953; PhD, Mech. Eng., Penn State U., 1961) has been with the Mechanical Engineering faculty for 3 years. Dr. Beans has approximately 7 years industrial experience with Battelle Memorial Institute and the North American Aviation Company Incorporated. In addition to teaching in the area of thermodynamics and fluids he has been working with graduate students studying the mixing of subsonic and supersonic streams. The object of this work is to prove the validity of a constant entropy assumption. His area of expertise is in the thermal and fluids engineering.

Assistant Professor JOHN F. BRIDGE (BSME, Iowa State U., 1955; MSc, Mech. Eng., OSU, 1960; PhD, ibid., 1963) has been on The Ohio State University, Mechanical Engineering Department faculty since 1963. He has industrial experience through seven summers of work at aircraft companies and at Battelle Memorial Institute. Although Dr. Bridge has an academic background in the area of turbulent flow, his recent interest has been in the area of bio-medical engineering.

Assistant Professor JOSEPH K. DAVIDSON (BSME-MSc, Mech. Eng., OSU, 1960; PhD, ibid., 1965) has been with the faculty for 7 years. Dr. Davidson has had consulting work with several industrial organizations and has been pursuing work in the area of mechanisms. He is recognized as an excellent teacher and has been participating with the students as the Faculty Advisor to the Student Chapter of the ASME and Tau Beta Pi. He received the Outstanding Teacher Award at the Student Scholarship Recognition Dinner in 1967.

Assistant Professor TRUMAN G. FOSTER (BSME, OSU, 1948; MSc, ibid, 1950; PhD, ibid., 1961) has been a member of this faculty for 17 years. Dr. Foster's area of expertise is in mechanical design. He has had extensive consulting work and has been very active in professional societies.

Assistant Professor DONALD R. HOUSER (BSME, U.of Wisconsin, 1964; MSc, ibid., 1965; PhD, ibid, 1969) joined the faculty of Mechanical Engineering in 1968. Dr. Houser has been specializing in the area of mechanical design and automatic control systems.

Assistant Professor ERIC K. JOHNSON (BSME, U. of Ill., 1953; MSc, ibid., 1957; PhD, Mech. Eng., U. of Wisconsin, 1967) has been with the Mechanical Engineering faculty for 3 years. Dr. Johnson has had previous teaching experience at the University of Illinois, Illinois Institute of Technology and the University of Wisconsin. He was a design engineer, a test engineer and a thermodynamist with several industrial organizations and has approximately 4 years industrial experience. He has been actively consulting with Battelle Memorial Institute and with the Columbia Gas Service Corporation in the area of combustion and heat transfer. Dr. Johnson has been pursuing research in the area of combustion and he has established contract research which supports one graduate student and a portion of his faculty wages.

Assistant Professor JAMES A. JORDAN (BS, U.S. Naval Academy, 1927; MSc, U. of Calif., Berkeley, 1937) has been with the Mechanical Engineering faculty for 12 years. Prior to joining this faculty he was professor of Naval Science and commanding officer of the OSU Naval Reserve Unit between 1954 and 1957. Assistant Professor Jordan had 30 years U.S. Navy experience in engineering, material, maintenance, and command of large U.S. Naval vessels.

Assistant Professor ROBERT A. KRAKOWSKI (BS, Chemical Eng., OSU, 1961; MSc, ibid, 1961; PhD, Nuc. Eng., U. of Calif., Berkeley, 1967) spent one year of post doctorate research at Ispra (Italy) Center for Research for Euratom. Dr. Krakowski is in the Nuclear Engineering Section as an experimentalist and teaches in the area of experimental nuclear energy conversion systems.

Assistant Professor HAROLD A. KURSTEDT, JR. (BS, Civil Eng., Virginia Military Inst., 1961; MSc, Nuc. Eng., U. of Illinois, 1963; PhD, ibid., 1968) joined the faculty of Mechanical Engineering in 1968 in the Nuclear Engineering Section. Dr. Kurstedt is acting chairman of the Nuclear Engineering Section and has numerous publications in the area of nuclear reactor power plant kinetics. He has demonstrated his abilities as an inspiring teacher and as a capable research director.

Assistant Professor BENNETT MILLER (BS, Physics, Columbia U., 1959; MA, ibid., 1961; PhD, ibid., 1965) joined the faculty in July of 1969. Dr. Miller has distinguished himself through his research work in the area of fusion nuclear energy conversion while at the Columbia University. He has a number of publications concerning his research work. He is a dynamic lecturer and an inspiring leader for graduate students pursuing work in the fusion area. Dr. Miller's responsibility is with the Nuclear Engineering Section and in teaching and directing research in nuclear fusion.

DR. JEROLD W. JONES (BSME, U. of Utah, 1962; MSc, Mech. Eng., Stanford U., 1965; PhD, Mech. Eng., U. of Utah, 1969) is a post doctorate pursuing research in the area of improving combustion in internal combustion engines and in furnaces. The approach is to apply a self-induced electrostatic field on fuel vaporization, with the electrostatic fields promoting breakup of the liquid particles. The research will investigate the feasibility of using this approach to improve combustion and hence reduce pollutants in exhaust gases.

DR. SHOICHIRO NAKAMURA (BS, Chemical Eng., Kyoto U., Japan, 1954; Doctor of Eng., ibid., 1967) is working on post doctoral research under the guidance of Professor Donald D. Glower. The area of the investigation is concerned with nuclear reactor transport theory and safety analysis.

MECHANICAL ENGINEERING DEPARTMENT FACILITIES

The remodeling of Robinson Laboratory in 1961-1963 provided approximately 100,000 square feet of modern air-conditioned facilities for laboratories, officies, classrooms and service facilities. The Mechanical Engineering Department utilizes most of the space in Robinson Laboratory, although there are approximately 12 classrooms which are used by the university as general classrooms. The Mechanical Engineering Department utilizes a number of the rooms for special laboratory functions. A few activities in these particular laboratories and some of the equipment are as follows.

Environmental Control. The environmental control laboratories in the Department of Mechanical Engineering consist of four separate rooms with a total floor area of 2,460 square feet. Two rooms are used exclusively for work in the field of acoustics. The third room is used for computation, and the fourth houses the main instruments and equipment used in the area of environmental control. One of the laboratories used for the area of acoustics is a semi-reverberant room and houses the following instruments which can be used for teaching and research in the area of acoustics: a transistor oscillator, a sound-level meter, dynamic and crystal microphones, and a sound analyzer. The above instruments are all manufactured by General Radio Company. Additional instrumentation used in acoustics and manufactured by the Bruel & Kjaer Company are: three condenser microphones, a portable sound-level meter, a beat-frequency oscillator, a random-noise generator, band-pass filter set, standing-wave apparatus, graphic level recorder, and frequency analyzer.

The computation laboratory has three Friden electric calculating machines. The large environmental laboratory houses four S. Sterling electronic-data loggers, three Hays circular-chart recorders, three Leeds & Northrup strip-chart recorders, four Honeywell strip-chart recorders, a half ton portable York refrigeration unit, a five ton portable York refrigeration system capable of reaching -60°F temperatures, a number of thermoelectric demonstration units for classroom use, a number of different air measuring devices such as a hot-wire anemometer, a vane-type anemometer, Pitot tubes with associated draft guages, a closed-air loop which can be used for research in the area of heat and mass transfer to extended surfaces. This air loop is capable of controlling air flow, temperature, and humidity. The laboratory also houses two electronic filters for demonstration purposes, a Vap-Air hygrometer system, a General Electric leak detector, an Eico 40 watt amplifier, a MacIntosh 100 watt amplifier, and a Westinghouse household refrigerator.

Thermal and Fluids. Thermal and fluids engineering laboratories include a number of air, liquid, and energy transfer apparatus. These equipment items are used in student laboratories and for student and faculty research. Major installed air handling facilities include: a rotary compressor (2.0 lb/sec at 40 psig), reciprocating compressor (0.4 lb/sec at 150 psig), a three-stage ejector vacuum system (1.0 lb/sec at atm.) and a 20,000 CFM blower. Three general purpose test tunnels include: a 200,000 CFM unit (32 ft^2 test section), a 30,000 CFM low turbulence wind tunnel (3 ft^2 test section), and a 2,000 CFM heat transfer tunnel (1.0 ft^2 test section) with heating, refrigerating, and humidifying facilities.

The hydraulics laboratory includes pumping and measuring facilities up to 6,000 gal/min.

The heat transfer facilities include instrumented test benches, heat exchangers, an altitude test chamber and a Mach-Zehuder interfrometer and associated measuring equipment.

The energy conversion laboratories include a variety of bench-top size turbo and positive displacement fluid power machines, and direct energy conversion devices, instrumented benches and associated dynamic measuring equipment.

Measurement Instrumentation. This field includes primary sensing elements and also the signal conditioning equipment necessary to process the basic data. Primary sensors cover the complete span of physical variables of importance to Mechanical Engineers and include accelerometers, potentiometers, velocity pickups, crystal and strain gage pressure pickups, flowmeters of many types, hot-wire anemometers, microphones, infra-red radiometers, load cells, strain gage equipment and humidity measuring systems. Signal processing equipment consists of bridges, amplifiers, spectrum analyzers, probability density analyzers, frequency-response test equipment and real time correlation and power-spectral density computers. A full range of recording equipment includes self-balancing potentiometers, x-y plotters, direct-writing and optical oscillographs, digital voltmeters, instrumentation and audio tape recorders and a variety of cathode-ray oscilloscopes including storage types.

Automatic Control Systems. This laboratory emphasizes demonstration and experimentation related to control system components of many types and also complete systems. A medium size electronic analog computer with a good selection of both linear and nonlinear components allows simulation of control systems of considerable complexity. A hydraulic power supply of 10 GPM and up to 5,000 psi is available for hydraulic system studies. A complete electro-hydraulic position servosystem with two-stage servovalve is instrumented for dynamic performance studies. Pneumatic control hardware includes PI and PID controllers, a pneumatic analog, electro-pneumatic transducers, valve positioner, nozzle-flopper amplifier and a good selection of both analog and digital fluidic components. Electrical servo drives using high-response DC servomotors, two-phase instrument motors and stepping motors are available. A mechanical simulator employing rate and position gyroscopes is used for demonstration of an on-off aircraft roll-stabilization system.

Automotive and Internal Combustion Engines. A numer of undergraduate students as well as graduate students are purusing work which studies techniques for improving the operating characteristics of engines, minimizes the pollutants which make up the exhaust gases, and for improving vehicle safety by analyzing accidents in cooperation with the state highway patrol. A few of the equipment items are listed below.

1 - 200 HP DC Dynamometer, 6,000 rpm maximum
1 - 100 HP DC Dynamometer, 3,500 rpm maximum
2 - 25 HP DC Dynamometers, 6,000 rpm maximum
1 - 25 HP DC Dynamometer, 3,000 rpm maximum
1 - 20 HP AC Synchronous Dyn. 900 rpm maximum
1 - 100 HP Chassis Dynamometer 70 mph maximum

Chrysler 383-4V Engine
International 4-153 Engine
Ford 260-2V Engine
Ford 289-2V Engine
Cummins 589 cu.in. V-6 Diesel Engine
GMC-Toroflow, 140 HP V-6 Diesel Engine
CFR Engines - 3 units

Exhaust Emission Equipment
NDIR for CO, CO_2, NOX
FID for hydrocarbons

Mechanical Design. In the area of mechanical design, a large amount of test and demonstration equipment is available for work in the sub-areas of kinematics, dynamics, vibration, fatigue, stress analysis, friction, and lubrication. The mechanical design laboratory emphasizes studies of physical properties, and includes many fatigue testers (both rotating, bending and push-pull types), an Instron universal tester, a high capacity hydraulic tester, two hardness testers, microscopes, strain gage equipment, and many special purpose test devices particularly for studies in fretting fatigue. One class room is used for kinematics and dynamics, and houses a large number of mechanisms, both models and actual hardware. Equipment available for experimental work in kinematics, dynamics, and vibrations includes two electromagnetic exciter systems; signal conditioners and analysers; capacitive, optical, inductive, and mechanical motion transducers; a complete telemetry system; several accelerometers; and all necessary oscilloscopes and recorders. A complete hydraulic system and dynamoneter test stand can be used for experiments in hydrostatic or hydrodynamic lubrication. An air hydrostatic bearing is used for research and demonstration purposes. Solid friction can be investigated on a test stand capable of measuring wear, temperature, and coefficient of friction as one member is rotated in contact with another.

Nuclear Engineering. The nuclear engineering section has special laboratories set aside for classroom teaching and for research. These laboratories include The Ohio State University Research Reactor Facility as well as laboratories for Counting and Subcritical work, Nuclear Instrumentation, and Research. The floor space utilized by these laboratories approximates 5000 square feet.

The OSU Reactor Facility. The OSU Reactor is a 16 foot deep, 10KW (th), pool-type reactor and is housed in a building which provides 3200 square feet of experimental area. The reactor is used for nucleonic experiments, reactor kinetics studies, isotope production, and activation analysis. Irradiation facilities consist of a graphite (or water) flux trap centrally located within the core, two beam ports, a beam chopper, rabbit tube, graphite thermal columns, and a bulk shielding facility capable of operating with a highly enriched (U^{235}) fission plate. In addition to housing control and experimental facilities, the reactor building contains an electronics laboratory and counting facility. The reactor is fitted with sensitive instrumentation needed for fine control during nuclear dynamics experimentation including apparatus for noise analyses and periodic reactivity insertions.

The Sub-Critical and Counting Laboratory. This laboratory provides 1000 square feet for basic laboratory counting work in neutronics, radiation detection, and radiation interactions. The graphite sub-critical pile is fueled with 2500 kg of depleted uranium and is activated with a 5 curie Plutonium/Beryllium neutron source. This nuclear reactor facility is used as an exponential pile or a sigma pile. Numerous radioactive sources of various strengths are available. Two "dry" irradiators provide roughly 10^5 r/Hr dose rates from 1000 curies of $C_o{}^{60}$. Radioactive sources of calibrative strengths, such as Radium D & E, Sr^{90}, C^{14}, $T_a{}^{204}$, B^{210}, $B_a{}^{123}$, $C_s{}^{137}$, $N_a{}^{22}$, $P_a{}^{234}$, $C_o{}^{57}$, are available for use in conjunction with radiation detection.

Most kinds of radiation detectors are used: Geiger-Muller counters, gas-flow proportional counters, organic (anthracene) and inorganic (sodium iodide) scintillation crystals, silicon barrier detectors, lithium drifted germanium detectors, BF_3 neutron dectectors, fission chambers, and calibrated activation foils. Electronic equipment used in detection systems is almost entirely of the AEC modular bin type and of such manufacture as Ortec, Tennelec, and Hamner. With this equipment coincidence/anti-coincidence counting, pulse-height analyses, and gamma spectroscopy can be performed. A 400 channel PHA is available for use with gamma spectra determinations, multiscaling experiments in the time mode as well as a complete Mossbauer spectrometer.

The Nuclear Instrumentation Laboratory. This laboratory is contained in approximately 550 square feet of floor space. This space includes the experimental as well as the teaching laboratory. Basic components such as Electronic power supplies, solid state devices including integrated circuits and printed circuit construction apparatus, as well as other instruments such as 100 megacycle oscilloscopes, are available. The laboratory developes the theory, experimentally verifies this theory, and provides a first hand experience at measuring nuclear radiation interactions with the various detection apparatus.

The Graduate Research Laboratory. This laboratory is used primarily for experimental research eventually leading towards theses and dissertations. A wide range of investigations are being performed in this laboratory, although present emphasis is directed towards materials research and detector development. Cryogenic and vacuum systems for general usage, sputtering, and annealing are available. Equipment pertinent to a research laboratory equipment is available.

Plasma and Fusion Research Laboratory. The Plasma and Fusion Research Laboratory is designed to provide students and faculty with the opportunity to investigate the properties of dense, high temperature gases. The main research device will be a conductivity coupled linear shock tube that is driven by a fast 100 kv capacitor tank comprised of 26^{BICC} - $\frac{1}{2}\mu f$, 100 kv, low inductance energy storage capacitors. The shock tube will produce plasmas with number densities in the range 10^{16} - 10^{17} ions/cc with temperatures of 10^6 - 10^7 $^\circ K$. In addition, a plasma arc generator is available for low temperature plasma studies.

It is anticipated that included among the diagnostic methods used to examine the plasmas there will be the following: laser, scattering and interferometry with holagraph fast magnetic field and pressure probes, microwave systems, and ferroelectric detectors.

Auxiliary equipment will include a 600 ℓ/s vacuum state, a 100 kv power supply, assorted smaller power supplies, and fast oscilloscopes with Polaroid camera attachments for instant data recording.

Figure 13. The department's laboratory facilities and the areas of particular interest of the faculty are combined each year in providing "Short Courses" as a service to the community. These courses vary in length from short lectures to several weeks duration. Topics include the very latest state of the art innovations in a particular area as well as review courses in such areas as heat transfer. This photograph shows Professor C. W. McLarnan explaining one of the finer points to a student, during a coffee break, in one of his short courses.

Figure 14. The very rapid advances made in our technology have forced us not only to consider the cooling and heating of a building but also other factors such as sound, light, air motion, air purification, etc. Environmental control must be imposed upon materials and devices as well as human beings. The heating and air conditioning laboratory shown in the photograph has been the site of many experimental analyses of innovative design in the areas of improved environmental control.

Figure 15. This research set-up incorporates a production heat pump. Tests are being run to determine, among other things, overall efficiency relative to defrosting frequency. The effect of core configuration and various surface treatments on frost formation and removal will also be studied.

Figure 16. Acoustics Project. The photograph shows noise reduction measurements being made on a partial noise enclosure. Brüel and Kjaer instruments are used for the noise measurements and analyses. Present acoustics research projects include: noise enclosures, machine noise, jet noise, and impact noise. Future work includes the construction of an acoustics laboratory and a reverberation room. Detailed studies will be conducted on the impact noise generated by a cold-heading machine, and the noise generated by a diffusing jet with mass addition. Shown in the photograph are Mr. Terry Shoup and Mr. Thomas Klausing (seated).

Figure 17. Under the guidance of Professor Velkoff, students adjust the flow control of a wind tunnel used for the study of helicopter and VTOL lift systems. The maximum velocity of 100 feet per second at the 4' x 8' test section coupled with rotor speeds of 1000 rpm adequately simulate forward flight conditions of helicopters. The wind tunnel was completely designed by Mechanical Engineering students.

Figure 18. A number of research investigations have been concerned with the influence upon the heat transfer characteristics of a static field placed across a moving gaseous stream. The research also applies to electrostatic power generation and to new techniques of fluid velocity measurement. Shown in the photograph is Mr. Duane Stucky. The results of these investigations are quickly utilized at all levels in courses of instruction.

Figure 19. The photograph shows the low turbulence wind tunnel facility. A low turbulence level is achieved due to the settling screens at the entrance and the large contraction from the settling screens to test section inlet. This facility is presently being used to study airflow about airfoils at subsonic speeds. This entails probing the trailing vortex system for size and strength. Future experiments will be performed to measure the effect of wake flow from one body on another, pressure distribution of bodies of arbitrary shape, and to improve flow visualization techniques.

Figure 20. A two-bladed, teetering model robot blade and associated hover stand. This stand is used to simulate a hovering helicopter for the purpose of studying the boundary layer flow on rotating blades. The experimental study includes the use of flow visualization techniques and electronic instrumentation. The students in the photograph are Mr. Dwight Blaser and Mr. E. Philip Bucher.

Figure 21. The Burnett apparatus is a highly accurate system for the measurement of the isothermal compressibility factor of gases over a wide range of pressures and temperatures. Mr. Billy Friar is shown with the apparatus. Related thermodynamic research in the area of equations of state, as well as other areas of thermodynamic theory, has almost always been of interest to several members of the faculty of this Department.

Figure 22. Professor E. O. Doebelin has authored several textbooks in the area of instrumentation and automatic controls. In the photo he is shown discussing a laboratory experiment with Mr. Bruce Bell and Mr. Jack Parker.

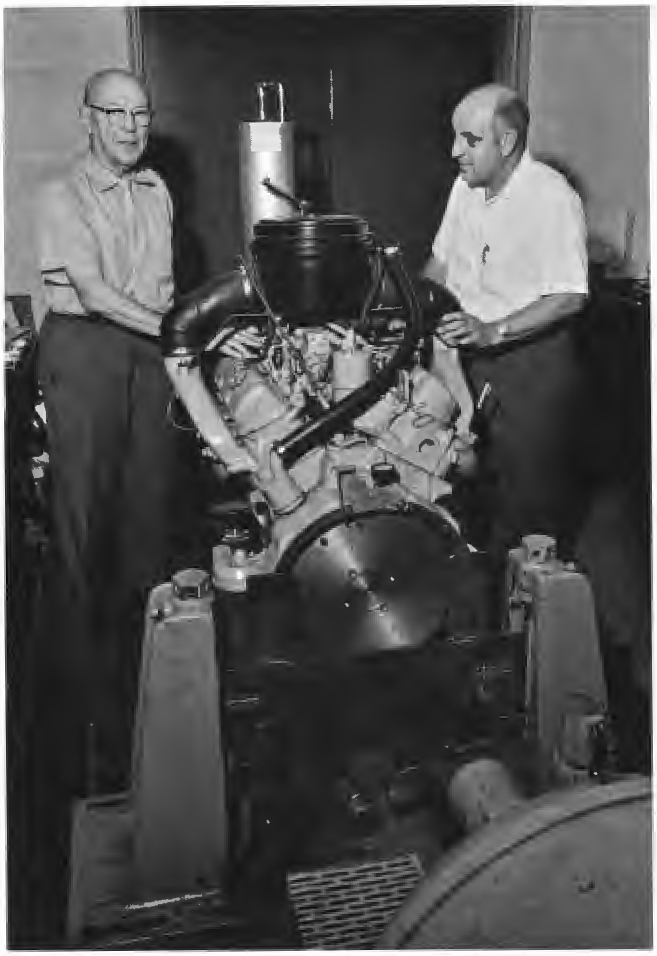

Figure 23. Professor Karl Stinson, (left), who first joined the faculty in 1916, is shown discussing one of the demonstration engines in the internal combustion laboratory with Associate Professor H. W. Engleman. Students have the opportunity to run tests on standard engines as well as on engines with which they have provided some design alteration. Manifold tuning, exhaust analysis, and electronic enhancement of ignition are representative of a few activities in the internal combustion engine laboratory.

Figure 24. Mr. John Csokmay is shown with an instrumented V-belt drive that he has designed to study belt-excited vibrations. The device will be used to determine such belt properties as dynamic modulus and damping coefficient and to investigate various types of belt irregularities as vibration exciters. Mr. Csokmay is a NASA Trainee in the Department of Mechanical Engineering.

Figure 25. Professors Marco, Starkey, and Foster look on as Mr. Milton Profant, a PhD candidate in Mechanical Engineering, makes adjustments on a brake lining tester developed in the department. The tester measures instantaneous values of frictional torque, normal pressure, and lining temperature as a rotating ring is forced against the lining. These data can then be used to obtain a rapid assessment of lining quality.

Figure 26. Students, Bruce Clark and Billy Friar, are shown working with a fatigue experiment. The role of fatigue and particular fretting-fatigue is an area in which several faculty members have become international experts. The students have available these renowned professors as well as a well-equipped laboratory which includes many types of material and system testing apparatus.

Figure 27. Stanley Miller sits at the controls of the University's nuclear reactor. The 10kW pool type reactor is utilized in instruction and research since it provides an intense source of neutrons and gamma radiation. Studies of the kinetics and control of nuclear reactors, activation analysis, and material damage studies illustrate the great versatility of this equipment.

Figure 28. The increasing role of women in engineering is a very important consideration. Women are encouraged to study and pursue careers in all fields of engineering. The Mechanical Engineering Department has Miss Cathy Colgan enrolled as a MSc candidate in Nuclear Engineering. She is shown here with some of the nuclear radiation counting apparatus.

Figure 29. Vacuum System. The need for a good and reliable vacuum presents itself in many areas of Nuclear Engineering. The system illustrated above is used to evaporate electrode substrates onto devices employed as radiation detectors. This versatile apparatus also houses an ion gun which is used to "sputter" mixtures of certain materials onto substrates, thereby forming thin films of relatively complex chemical structure. An experiment is presently being conducted in which a beam of argon ions is directed alternately onto a titanium and a barium target. The sputtered atoms condense on a substrate to form barium titanate, a ferroelectric ceramic which has some application in the detection of radiation. The vacuum system can also house a high temperature furnace and is used to perform high-temperature vacuum anneals associated with studies on many kinds of nuclear engineering materials used as radiation detectors and nuclear fuels.

Figure 30. Mössbauer Effect Spectrometer. The apparatus shown above is used in basic Nuclear Engineering courses to demonstrate the principle of nuclear resonance absorption and scattering of gamma rays by matter. The Mössbauer effect results from a coupling between nuclear and chemical (atomic) states and, hence presents a new and attractive method for investigating many physical phenomena. The principle behind this new experimental tool rests with the interaction between the nuclear charge and that of the electron shells, the interaction between the nuclear magnetic moment and external (or intermolecular) magnetic fields, or the interaction of the nuclear electric quadrupole moments and external (or intramolecular) inhomogeneous electric fields. The Mössbauer effect is being employed to investigate solid state diffusion and tarnishing processes which lead to alterations in valence states or stress environments associated with the Mössbauer nucleus in the crystalline test specimen.

Figure 31. A satisfactory steady state nuclear fusion reaction has not to date been attained. There is little doubt that such a reaction will become a reality in the not too distant future. The Mechanical Engineering Department's Nuclear Engineering Section is establishing a state-of-the-art program since many of the fusion problems are mechanical engineering problems. Shown in the photograph is Mr. Dennis Guenther, a graduate student, with a group of 100kV capacitors which are used for energy storage in the Fusion Laboratory.

A FEW GRADUATES OF THE DEPARTMENT OF MECHANICAL ENGINEERING WHO HAVE MADE SPECIAL CONTRIBUTIONS TO CIVILIZATION AND HUMAN WELFARE

"The graduates of the Department of Mechanical Engineering at The Ohio State University have proven their ability as consulting engineers, research engineers, inventors, manufacturers, designers, engineering salesmen and in numerous other ways. At one time, of the ten heads of engineering departments at the Westinghouse Electric and Manufacturing Company, seven were Ohio State graduates in Mechanical or Electrical Engineering. At about the same time the sales manager and the electrical superintendent of the General Electric Company were Mechanical Engineering graduates." This quotation was taken from the early history of the Department as written by former Dean Hitchcock. It serves to illustrate that the graduates of our Department have distinguished themselves and their profession and by so doing have added distinction and glory to themselves and their University. It would be possible to single out all of the graduates of the Mechanical Engineering Department for special mention; however, the following lists only a few of these graduates who have distinguished themselves and who have remained in contact with the University.

In the early history of the Department, perhaps the best known aluminus was BENJAMIN G. LAMME, ME class of 1888, late chief engineer of the Westinghouse Electric Company and inventor of much of the notable and important electric machinery. NORMAN W. STORER, ME class of 1891, was well known for his successful work with the Westinghouse Electric and Manufacturing Company, in particular, with regard to the electrification of steam railroads. CHARLES F. MARVIN, ME class of 1883, was professor of meteorology at The Ohio State University and chief of the United States Weather Bureau in 1913. He was the inventor of numerous meteorological instruments and machines, many of which are still in use today. Another prominent ME graduate was CHARLES E. SKINNER who worked with the research division at Westinghouse and was chairman of the International Electrical Chemical Commission. SAMUEL S. WYER distinguished himself by specializing in gas and oil and practicing before the courts including the Supreme Court of the United States. ERVIN G. BAILEY, ME class of 1903, made great contributions through his technical knowledge of the combustion of fuel and through his inventions. His work facilitated the operation of very large boiler rooms in a practically automatic fashion, thereby relieving many men from the dirty, disagreeable and hot work of the boiler room. Mr. Bailey has received every award that The Ohio State University can conceivably give. He founded the Bailey Meter Company and was later Vice President of the Babcock and Wilcox Company. He has received many awards from his professional societies and has been President of the ASME. He has received medals and the honorary doctorate degree from The Ohio State University. He was one of the few Americans to be elected an honorary member of the Institution of Mechanical Engineers in England. GEORGE R. BOTT and DWIGHT E. BATESOLE worked with the Norman Company of America and did much to introduce and perfect the use of ball bearings. JOSEPH N. BRADFORD, ME class of 1883, left his mark on the University through many buildings designed and erected under his direction while University Architect. Among numerous inventions in designs, mention should be made of those by DALE M. BOOTHMAN for his inventions concerning the manufacture of shredded wheat, FRED B. HENRY and LESTER S. KEILHOLTZ for their inventions for the Frigidaire Corporation and FREDERICK W. SEYBOLD for the design of paper cutting machinery.

The following list singles out a few of the graduates who have received awards from the University.

PAUL L. ALSPAUGH, BME 1928, must be singled out to acknowledge his pioneering contributions to the technology and production of hydrocarbon gas and titanium, his proven executive and administrative abilities, and his leadership in the affairs in his profession. Mr. Alspaugh was named President of the Union Carbide Olefins Company in 1961.

ERWIN G. BAILEY, previously mentioned as one of the distinguished early graduates of the Department, was a graduate of 1903, and the inventor of the Bailey Meter as well as numerous other inventions which resulted in between 50 and 100 patents. Mr Bailey was truly one of the distinguished engineers of the industrial revolution.

PHILIP C. BOWSER, BME 1950, was promoted to Director of Research and Development of the Buick Motor Division of the General Motors Corporation in 1959. Among his contributions are new types of ball joints and front-end suspension anti-drive mechanisms which became standard in the auto industry. He was responsible for a number of original designs and devices for improving the comfort and safety of passenger vehicles. He holds many patents. He received the College of Engineering Texnikoi Award in 1968.

RALPH L. BOYER, BME 1924, ME 1931, received the Benjamin G. Lamme Award in 1951. He was a Vice President and Director of the Cooper-Bessemer Corporation. Among his many contributions are the high compression gas engine and the jet type gas turbine. His contributions to gas and diesel engines did much to further this area of our technology.

WILLIAM R. CHAMBERS, a graduate of Mechanical Engineering in 1904, received the Benjamin G. Lamme Award in 1963. Mr. Chambers was an eminent engineer, administrator and educator in the field of mechanical engineering, and a profilic contributor to the advancement of engineering technology during war and peace. He is responsible for the site of Oak Ridge National Laboratories and was chief engineer of American Steel Castings Company. In 1963, the village of Oak Ridge held a "Chambers Day" in recognition of his civic contributions during the 20th Anniversary of the establishment of Oak Ridge.

ALTON F. DAVIS, ME-EE 1914, received the Distinguished Alumnus Award in 1955. Mt. Union College awarded him an honorary doctorate of science degree in 1951. Mr. Davis was Vice President and Secretary of Lincoln Electric Company, Cleveland, Ohio. He established the Davis Welding Library at The Ohio State University. His numerous contributions to the welding industry received top recognition as is indicated by his receiving the top honor in the American Welding Society, the Samuel Wiley Miller Medal, in 1954. He established an A. F. Davis Welding Award for undergraduates in Welding Engineering at The Ohio State University.

THEODORE T. FRANKENBERG, BME 1934, received the Distinguished Alumnus Award in 1957. Mr. Frankenberg made outstanding advancements in the design and development of high-pressure, high-temperature power generation plants. He participated in and created innovations for the advancement of the concept of automatic control of large steam power plants, and made contributions to engineering education through student and alumni activities.

THOMAS E. FRENCH, BME 1895, received the Lamme Medal in 1943. Mr. French was well known for his textbook on engineering drawing, a book which is used throughout the world. For 21 years he was the faculty representative for the Western Conference (Athletics) and at Ohio State was known as the Father of the Western Conference. He was instrumental in admitting OSU to the Big "9". Mr. French submitted the plans for our horseshoe shaped stadium, which were approved. The French Field House was named in his honor.

HAYWARD A. GAY, ME 1930, received the Texnikoi Award in 1955, and the Benjamin G. Lamme Award in 1965. Mr. Gay received further academic training at Harvard University and obtained the MBA in 1932. Mr. Gay has held many administrative posts during his professional career and through his leadership he has gained an international reputation. His contributions have been made in the areas of marketing and administrative techniques applicable to large industrial combines. The success of his management abilities has lead to the welfare and well being of thousands of American citizens. His talents were recognized in 1967, when he was appointed Vice President and Group Executive of the Colt Industries with responsibility for seven operations.

RAYMOND P. GREENE, IE-ME 1937, received the Distinguished Alumnus Award in 1963. Mr. Greene was elected President in 1966, of the Ray Greene and Company, Incorporated. Mr. Greene has pioneered in design, development and sales of pleasure boats. His company which is located in Maumee, Ohio, has attained national prominence.

O. WILLIAM HABEL received his BME degree in 1923, and was designated a Distinguished Alumnus in 1962. His genius in the engineering and management of automotive production, his leadership in community betterment, and his significant efforts for the advancement of education lead to his receiving the Distinguished Alumnus Award. Mr. Habel was appointed General Manager of the Detroit Transmission Division of General Motors Corporation in 1956, and retired from that position in 1964. He received the honorary degree Doctor of Science and Business Administration from Cleary College in 1960.

RALPH M. HARDGROVE received his BME degree in 1914, and was awarded the Benjamin G. Lamme Medal in 1955. Mr. Hardgrove had numerous inventions including inventions of the cyclone furnace, the Peggle heater and the Cascade furnace. He is an authority on fuel burners and furnaces. During his professional career with The Babcock and Wilcox Company he published more than twenty technical papers and obtained 98 patents.

WILLIAM M. HOLADAY received the ME degree in 1925 and was given the Distinguished Alumnus Award in 1960. Mr. Holaday rose to the Directorship of Research with Secony-Vacuum Oil Company where he had distinguished himself as a specialist in aircraft fields. President Eisenhower named him as the Guided Missile Chief of the Civilian Military Liaison Committee under the Secretary of Defense. His award was given in recognition of his contributions to the field of Mechanical Engineering, his outstanding executive and administrative skills in the petroleum industry, and his leadership in research and development in our national defense.

CLETUS M. HUGUENARD received the BME degree in 1951 and the MSc degree in 1951. He was designated a Distinguished Alumnus in 1959, in acknowledgement for his phenomenal rise in engineering prominence, and for his technical contributions and outstanding administrative skill applied to the design, development, and production of America's most advanced defense system. In 1969, Mr. Huguenard was appointed Manager of Test Operations of the Flight Propulsion Division of the General Electric Company in Cincinnati.

WILLIAM H. JAQUES received his ME degree in 1941 and was given the Distinguished Alumnus Award in 1966. Mr. Jaques was Director of Technical Services in the Engineering Division of Procter and Gamble Company of Cincinnati. His award was for his distinction as a creative engineer, technical administrator, servant in civic affairs, and a leader in his profession..

ALBERT E. KIMBERLY was awarded the Bachelor's Degree in Mechanical Engineering in 1934 and a Master of Science Degree in 1935. The Distinguished Alumnus Award was presented to Mr. Kimberly in 1963 in honor of his leadership in the field of automotive engineering and administration, his achievements in creative project development and reliability, and his dedicated service to his University and to engineering education. Mr. Kimberly was Chief Engineer, Vehicle Reliability, of the Chrysler Corporation at the time he received his award as a distinguished alumnus.

KERMIT T. KUCK received a Bachelor's Degree in Mechanical Engineering in 1934 and was awarded a Distinguished Alumnus Plaque in 1965. He received this award in recognition of his exemplary career during which successive and progressive achievements were made as an engineer and executive in an industry strongly dependent on sound engineering. Mr. Kuck was President of the Monarch Machine Tool Company of Sidney, Ohio, at the time he received this award. During his tenure with the company, and due a great degree to his personal contributions, the Monarch Machine Tool Company introduced new product designs and maintained a quality of products which gained the Company the reputation for leadership in the metal machining industry. Examples of his engineering achievements are Monarch's development and application of single point turning and the Company's pioneering development of the use of preselected head stock shifting.

ALLEN G. LOOFBOURROW graduated in 1934 and received the Benjamin G. Lamme Meritorious Achievement Medal in 1960. Mr. Loofbourrow demonstrated his technical and creative ability through 54 patent disclosures and 13 patents. These technical creations were in the area of automotive engineering and included such innovations as torsion bar suspension, push button gear shift, three speed automatic transmissions, etc. Mr. Loofbourrow was Vice President of the Chrysler Corporation in charge of quality and reliability.

WILLIAM A. MEITER graduated with a degree in Mechanical Engineering in 1927. He was awarded the Distinguished Alumnus Award in 1961 for his outstanding achievements and demonstrated abilities, his leadership in the affairs of his profession, his proven administrative and executive skills, and his continued interest in education. Prior to his retirement from the Worthington Corporation he was Vice President in charge of employee and public relations.

RALPH D. MERSHON obtained the Bachelor's Degree in Mechanical Engineering in 1890 and was awarded the Benjamin G. Lamme Medal in 1932. Mr. Mershon was a prolific inventor, having created the six phase rotary converter and compensating volt meter, devised a system for protection of electrical apparatus from lightning and designed various electrical power plants in the United States, South Africa and Japan. He was one of four people responsible for the concept of ROTC on the university campuses throughout the United States. He had approximately 75 inventions at the time of his death. At that time he was President of the Engineering Institute of Canada and the American Chemical Society. Mr. Mershon left over seven million dollars to The Ohio State University and a portion of these funds was spent in building the living memorial, the Mershon Auditorium, which is now housed on the Campus and a cultural center in Columbus as well as in the university community. In addition, interest from a portion of the funds donated to The Ohio State University is used for the support of graduate students and faculty.

FORREST K. POLING graduated in Mechanical Engineering in 1948. He was given the Texnikoi Award in 1965. Mr. Poling, Executive Engineer, Car Product Engineering Office, joined the Ford Motor Company in 1949, after graduation and his vigor and talent carried him from development engineering and later product design to the position as Executive Engineer. He is credited with five million dollars in cost reduction while maintaining quality in his area of responsibility. He demonstrated his technical and administrative abilities through assignments in chassis components developed for the Thunderbird, the Falcon and the Comet automobiles. He has been responsible for many innovations throughout the Ford Motor Company product line.

ESTEL C. RANEY graduated in 1912, with a ME-EE degree. He received the Benjamin G. Lamme Award in 1947. Mr. Raney has over 100 patents and has the original patent in automatic reclosing circuit breakers. He founded the Automatic Reclosing Circuit Breaker Company which is now known as Ranco Incorporated. The company he founded has reached seventy million dollars annual sales volume, hiring thousands of people.

HARRY J. SANDS, JR. graduated in 1938 and was given the Distinguished Alumnus Award in 1960. In 1968, he was a Major General in the U. S. Air Force. He made significant developments in the area of aircraft and guided missiles.

JACOB W. SCHAEFER obtained a BME degree in 1941 and was nominated for and received the Distinguished Alumnus Award in 1966. As the director of Data Communications Laboratory of the Bell Telephone Lab he worked in the design and development of anti-aircraft fire control equipment and guided missiles. He was a specialist in electronics and holds patents involving guidance and tracking of guided missiles.

JOHN C. SHARP obtained a BME degree in 1923, and was designated a Distinguished Alumnus Award in 1955. He was Vice President and Chief Engineer of the Hotpoint Company in Chicago with responsibilities for the engineering and design that pioneered matched appliance groups for complete electric kitchens and automatic home laundries. He received national citations for major appliance designs including automatic push button cooking, the moistureless dryer, and the fully automatic electric dishwasher.

CHARLES E. SKINNER was mentioned previously among the early graduates, having received his EME degree in 1890. He received the Lamme Award in 1931, and an Honorary Doctor of Science Degree in 1935 from Ohio University in Athens. He was the founder and Director Emeritus of the Westinghouse Research lab and was associated with these laboratories for fourty-three years. His pioneer work in insulation design and testing and in the rating of electrical machinery has had a large influence on the standards adopted both nationally and internationally for these subjects.

DISTINGUISHED GRADUATES OF RECENT YEARS WHO HAVE MADE SIGNIFICANT CONTRIBUTIONS TO THEIR PROFESSION AND TO THE WELFARE OF MANKIND

GEORGE E. ARMINGTON received a BME degree in 1925, and was Chairman of the Board of the Euclid Crane and Hoist Company of Cleveland, Ohio. He distinguished himself in the area of technical development and management. HUGH M. BONE graduated in 1911, and attained the position as Chairman of the Board of the Ironside Company in Columbus, Ohio. ROBERT E. DINE obtained a Master's Degree in 1948. He gradually climbed through the technical and management ranks attaining the position as manager of the Scranton Defense Plant of the Chrysler Corporation. ALFRED G. ERWIN obtained a BME degree in 1950, after which he joined the Westinghouse Electric Corporation. He worked as an engineer in various jobs, and subsequently went into management and attained a position as Manager of Manufacturing Planning of the Westinghouse Electric Corporation. STUART F. FAUNCE obtained a BME degree in 1948. Mr. Faunce mixed a career of teaching and research, obtaining the position of Vice President and Director of Engineering Research of the Multi Division Metal Fabric and Appliance Company of the John Wood Company. He later moved to be Manager of Engineering and Research with Hewitt-Robins Incorporated of Pasaic, New Jersey. He has a number of patents and publications. JOHN H. FELLOWS graduated in 1949, and worked with the Timken Roller Bearing Company. He advanced to Assistant General Manager of the Sales Division. His contributions were in management and marketing. DONALD W. GAMES obtained a BME degree in 1947, and after graduation joined the Lincoln Electric Company in Cleveland. He was one of three men who formed the Production Machinery Company in 1956. He became the Vice President and Director of Sales as well as the Secretary of his new corporation. ARCHIE L. GEISINGER obtained an ME degree in 1914. He was Vice President of the Diamond Alkali Company in 1951, and at the same time he was President of the Martin Dennis Company of Newark, New Jersey, one of Diamond's Divisions. He designed, supervised, constructed and later operated Diamond's first silicate plant at Cincinnati, Ohio. NAGLE V. GUSCHING obtained a BME degree in 1947. He joined the Monarch Machine Tool Company and made many mechanical innovations. He is Vice President in charge of engineering. JACK M. HULTZ received a BME degree in 1949, and began work with the Anchor Hocking Glass Corporation of Lancaster, Ohio. He attended the Harvard Business School and later joined the Pfaudlar Company in Elyria, Ohio. He made his career with the Pfaudlar Company being appointed its President in 1965. LEO V. KLINE obtained a BME degree at the University of Akron in 1950, and the MSc and PhD degrees from Ohio State. His Doctor's Degree was granted in 1954. He mixed a teaching and industrial career, beginning his career of teaching at Purdue University. He later joined the IBM Corporation and advanced to Manager of Advanced Technology at Raleigh, North Carolina. DAVID J. MASSON obtained a BME degree in 1943, the MSc in 1946, and then transferred to Aero Astronautics and received a PhD degree in 1952. After a distinguished career with Rand Corporation he left for an executive position with Litton Industries at their Beverly Hills, California, office. LOREN A. MURPHY obtained a BME degree in 1925. He joined the Goodyear Tire and Rubber Company of Akron, Ohio, in 1925, and made his professional career with that company. He retired in 1968, as Vice President. FRANCIS J. McELHATTON obtained the BME degree in 1936. After completing the BME degree Mr. McElhatton joined the Panhandle Eastern Pipeline Company. He has made his career with this company and has made significant developments in the area of corrosion control devices which increased efficiency and reduced maintenance problems. He is one of the two remaining active founders of the National Association of Corrosion

Engineers. He has had many citations and recognitions and is currently the Senior Vice President of the Panhandle Eastern Pipeline Company and President of the National Helium Corporation. JAMES H. McFEE obtained the BME-BIE degree in 1935. After receiving this degree he started with the Research Organization of the Anchor Hocking Glass Company. He has been with that company since 1932, and is currently the Vice President in charge of engineering and research. ELNO M. POWELL obtained the BME degree in 1934, and immediately thereafter joined the Combustion Engineering Company. He has made his career with this company rising through the ranks to Vice President in charge of engineering. RALPH E. STINSON obtained a BME degree in 1948, and joined the Bettcher Manufacturing Company in Cleveland, Ohio, immediately upon graduation. He has made his career with this company and is now its President and Director. GERALD E. TENNY obtained a BME degree in 1915. He worked for many years as Service Manager and Director of the Lincoln Electric Company in Cleveland, Ohio. More recently he has been President of GET Incorporated of Chargin Falls, Ohio. He is the past President of the Alumni Association and is still very active in University affairs. He received a plaque in 1964, for outstanding service to the University. FRANCIS E. WEISEND obtained a BME degree in 1938. He started his professional career with the B. F. Goodrich Company in Akron and continued with this same company reaching the position as Plant Manager of the Industrial Products Division. He is also Vice President of the Board of Directors of the Marietta Chamber of Commerce and President of the Marietta Memorial Hospital Board. JOHN B. WHITE received his BME degree in 1952, and immediately upon graduation went to work with the Pittsburgh Plate Glass Industries Incorporated. While working with this company he made many contributions which have resulted in the improved production and quality of glass. His technical contributions resulted in his being promoted to the position as Vice President of Manufacturing reflecting responsibilities in the Engineering Department and Glass Purchasing Department as well as Glass Production.

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APPENDIX A

MECHANICAL ENGINEERING FACULTY
1878 - 1969

MECHANICAL ENGINEERING FACULTY*

1878-1969

		Academic Year Beginning
S. W. Robinson	Professor	1878-1893
	On leave	1894
	Emeritus Professor	1900-1910
William Mason, Jr.	Assistant Professor of Industrial Arts	1881-1882
Frank H. Eldridge	Professor of Steam Engineering	1882-1884
Embury A. Hitchcock	Asst. Prof. of Mechanical Engineering	1895-1911
	On leave	1912
	Resigned	1913
William T. Magruder	Chairman & Prof. of Mech. Eng.	1896-1930
	Professor of Mech. Eng.	1931-1932
	Emeritus Professor	1933-1934
Horace Judd	Asst. Prof. of Experimental Eng.	1901-1917
	Assoc. Prof. of Hydraulic Eng.	1918
	Assoc. Prof. of Mech. Eng.	1919
	Professor of Mechanical Engineering	1920-1938
	Emeritus Professor	1939-1945
Roy Stevenson King	Asst. Prof. of Experimental Eng.	1905-1906
Carl Rigdon	Asst. Prof. of Experimental Eng.	1908-1909
Horace Nelson Packard	Asst. Prof. of Experimental Eng.	1909
Alexander Vallance	Asst. Prof. of Experimental Eng.	1910-1912
F. W. Marquis	Professor of Steam Engineering	1913-1930
	Professor and Chairman	1931-1941
	On leave	1941-1944
	Professor and Chairman	1945
	Professor	1946-1952
	Emeritus Professor	1953-
Aubrey I. Brown	Instructor, Mech. Eng.	1913-1916
	Asst. Prof., Mech. Eng.	1918-1927
	Assoc. Prof., Mech. Eng.	1928-1932
	Professor	1933-1941
	Acting Chairman and Professor	1942-1944
	Professor	1945
	Chairman and Professor	1946-1951
	Professor	1952-1957
	Emeritus Professor	1958

*Compiled from College Catalogues, Faculty and Staff Directories

		Academic Year Beginning
Carl A. Norman	Professor of Machine Design	1918-1948
	Emeritus Professor	1949-1969
Paul Bucher	Instructor, Mech. Eng.	1918-1921
	Assistant Professor	1922-1929
	Associate Professor	1930-1933
	Professor	1934-1959
	Emeritus Professor	1960-1969
Karl W. Stinson	Instructor, Mech. Eng.	1920-1923
	Assistant Professor	1924-1929
	Associate Professor	1930-1933
	Professor	1934-1962
	Emeritus Professor	1963-
Fay A. Dunn	Instructor, Mech. Eng.	1920-1921
Roland H. Wasson	Instructor, Mech. Eng.	1920-1923
Harold M. Jacklin	Instauctor, Mech. Eng.	1920-1925
	Assistant Professor	1926
George Moffat	Instructor, Mech. Eng.	1923-1929
	Assistant Professor	1930-1938
	Associate Professor	1939-1943
	Professor	1944-1961
	Emeritus Professor	1962-
Samuel Beitler	Instructor	1923-1929
	Assistant Professor	1930-1938
	Associate Professor	1939-1943
	Professor	1944-1961
	Emeritus Professor	1962
C. P. Roberts	Instructor	1922-1929
	Assistant Professor	1930-1938
	Associate Professor	1939-1946
	Professor	1947-1959
John O. Harshman	Instructor	1923-1926
Andrew Fairbanks	Assistant Professor	1930-1932
S. M. Marco	Instructor	1935-1939
	Assistant Professor	1940-1944
	Associate Professor	1945-1946
	Professor	1947-1951
	Professor and Chairman	1952-1967
	Professor	1968
E. J. Lindahl	Instructor	1939-1941
	Assistant Professor	1942-1945
	Associate Professor	1946

		Academic Year Beginning
William Stube	Instructor	1940
Walter Robinson	Instructor	1942-1943
	On leave	1944-1945
	Assistant Professor	1948-1952
	Associate Professor	1953-1955
Edmund B. Neil	Associate Professor	1943-1945
John E. Applegate	Instructor	1946
	Instructor	1948
Lee Toliver	Instructor	1946
Richard H. Zimmerman	Instructor	1946-1947
	Assistant Professor	1948-1952
	Associate Professor	1953-1956
	Professor	1957-1961
	On leave	1962-1963
	Professor	1964-1965
Francis S. Tse	Instructor	1947-1951
George W. Soiya	Instructor	1947
William R. Alexander	Instructor	1948-1950
William Zartman	Instructor	1949-1950
	On military leave	1951-1952
Truman G. Foster	Instructor	1949-1959
	Assistant Professor	1960-
Owen E. Buxton, Jr.	Instructor	1953-1957
	Assistant Professor	1958-1967
	Associate Professor	1968-
Charles D. Jones	Instructor	1954-1955
	Assistant Professor	1956-1960
	Associate Professor	1961-1963
	Professor	1964-
James E. Michaels	Instructor	1953
Harold A. Bolz	Professor	1954-1961
Jesse Huckert	Professor	1947-1954
Walter L. Starkey	Instructor	1947
	Instructor	1949
	Assistant Professor	1950-1953
	Associate Professor	1954-1957
	Professor	1958-

		Academic Year Beginning
Horace R. Lowers	Instructor	1947
Marion L. Smith	Instructor	1947-1949
	Assistant Professor	1950-1954
	Associate Professor	1955
	On leave	1956
	Associate Professor	1957-1968
	Professor	1969
Donald H. Whiston	Instructor	1947
David J. Masson	Instructor	1947-1951
Ward E. Christie	Instructor	1947
George D. Hudelson	Instructor	1947-1950
	Assistant Professor	1951-1956
	On leave	1957
Gennaro Coglia	Instructor	1947-1950
Robert E. Dine	Instructor	1947-1950
	Assistant Professor	1951
	On leave	1952-1953
Ernest O. Doebelin	Instructor	1954-1957
	Assistant Professor	1958-1962
	Associate Professor	1963-1966
	Professor	1967
Charles W. McLarnan	Instructor	1954-1959
	Assistant Professor	1960-1962
	Associate Professor	1963-1967
	Professor	1968
William C. Davis	Instructor	1955
Charles D. Nash, Jr.	Instructor	1956-1958
	Assistant Professor	1959-1961
Lit Sien Han	Assistant Professor	1956-1957
	Associate Professor	1958-1960
	Professor	1961
	On leave	1962
	Professor	1963-
Robert R. Gatts	Instructor	1956-1957
	Assistant Professor	1958
Kenneth G. Hornung	Instructor	1956-1958
	Assistant Professor	1959-1962
	Associate Professor	1963-1966
	Professor	1967-

		Academic Year Beginning
Charles F. Sepsy	Instructor Assistant Professor Associate Professor Professor	1956-1959 1960-1963 1964-1967 1968-
Carl H. Wolgemuth	Instructor	1956-1962
James A. Jordan	Assistant Professor	1957-
Stanley Angrist	Instructor	1956-1961
John M. Boyd	Instructor Assistant Professor	1956-1961 1962-1965
John F. Bridge	Instructor Instructor Assistant Professor	1957-1959 1961-1963 1964-
Ralph C. Hall	Instructor	1957
Edward Kern	Instructor	1957
Hassan Marandi	Instructor	1957
John Williamson	Instructor	1957-1962
Randall F. Barron	Instructor	1958-1962
Kenneth L. Bergman	Instructor	1958-1960
Ross Day	Instructor	1958-1960
Wendell Williams	Instructor	1958-1965
Samuel Lefkowitz	Instructor	1959-1962
Virgil Lundarini, Jr.	Instructor	1959-1962
Norman Schnurr	Instructor	1959-1962
E. William Beans	Lecturer Assistant Professor	1962 1966-
Deane Kihara	Instructor	1962
William C. Cariens	Instructor	1962
Henry R. Velkoff	Associate Professor Professor	1963-1966 1967-
John G. Bishel	Instructor Instructor	1963 1965
Harold R. Jacobs	Instructor	1963

		Academic Year Beginning
George Pfannebacker	Instructor	1963-1964
Donald D. Glower	Associate Professor Professor Professor and Chairman	1964-1966 1967 1968-
Juin S. Yu	Assistant Professor	1964-1967
Joseph K. Davidson	Instructor Assistant Professor	1964 1965-
Helmuth W. Engelman	Associate Professor	1965-
James H. Brann	Assistant Professor	1965
Eric K. Johnson	Instructor Assistant Professor	1965 1966-
Donald C. Brunton	Adjunct Assoc. Prof., Nuclear Eng.	1966-
Robert Redmond	Adjunct Assoc. Prof., Nuclear Eng.	1966-
John E. Lynch	Assistant Prof., Nuclear Eng. Associate Prof., Nuclear Eng.	1967-1968 1969-
Michael J. Moran	Assistant Professor Associate Professor	1967-1968 1969-
Donald R. Houser	Assistant Professor	1968-
Harold A. Kurstedt, Jr.	Assistant Prof., Nuclear Eng.	1968-
Robert A. Krakowski	Assistant Prof., Nuclear Eng.	1968-
Harold Epstein	Adjunct Assoc. Prof., Nuclear Eng.	1969-
Bennett Miller	Assistant Prof., Nuclear Eng.	1969-

+ 3 Postdoctorates

APPENDIX B

ORGANIZATION CHART

MECHANICAL ENGINEERING DEPARTMENT

THE OHIO STATE UNIVERSITY

OCTOBER, 1969

Department Chairman

D. D. Glower

Assistant to Chairman

J. A. Jordan

Policy Committee

D. D. Glower, Chm.
K. G. Hornung
C. D. Jones
J. A. Jordan (Sec.)
H. A. Kurstedt
H. R. Velkoff

Mechanical Design Section

K. G. Hornung, Chm.
J. K. Davidson
T. G. Foster
S. M. Marco
W. L. Starkey

Thermal and Fluids Engineering Section

H. R. Velkoff, Chm.
E. W. Beans
J. F. Bridge
L. S. Han
E. K. Johnson
J. W. Jones (PostDoc)
J. A. Jordan

Systems Design and Automatic Controls Section

C. D. Jones, Chm.
O. E. Buxton
E. O. Doebelin
H. W. Engelman
D. R. Houser
C. F. Sepsy

Nuclear Engineering Section

H. A. Kurstedt, Act.Chm.
D. C. Brunton, Adj.
H. M. Epstein, Adj.
R. A. Krakowski
J. E. Lynch
B. Miller
S. Nakamura (PostDoc)
R. F. Redmond, Adj.

	Beans	Blaser	Bridge	Buxton	Davidson	Daugherty	Doebelin	Engelman	Foster	Glower	Guenther	Han	Henderson	Hornung	Houser	Johnson	Jones	Jordan	Kauffmann	Krakowski	Kurstedt	Lynch	Marco	Miller (Ben)	Miller (Don)	Moran	Sepsy	Starkey	Thompson	Tipton	Velkoff
1. Advanced Professional Program									C	x				x			x	x			x										x
2. Curriculum Mechanical						x	x			x		x		C			x				x						x				
3. Curriculum Nuclear										x				x						x	C	x		x	x						
4. Graduate Mechanical			x														C														
5. Graduate Nuclear										C							x			x	x	x		x							
6. Library					C																x										
7. Laboratory Development	x			x			C			x					x					x				x							
8. Publicity											x		x					x	x												
9. Research										x		x				x				x				x			x	x			C
10. Seminars										x														CC	x	CC			x		
11. Short Courses		x					x			x											C		x	x			x	x			
12. Special Events					C					x			x				x	x												x	
13. Space - Office and Lab										x							C														
14. Shop - Grad and Technicians								x																							

C = COMMITTEE CHAIRMAN